

\angle	\perp	\parallel	\emptyset	\circ	\smile	\triangle	\square	\square	\square	\circ	\equiv	\equiv	\equiv
$+$	$-$	\times	\div	$=$	\neq	\leq	\geq	\propto	\pm	$*$	$ $	$ $	$ $
f	Π	Σ	\int	Δ	∇	∂	∞	\rightarrow	\dots	\dots	\dots	\dots	\dots
\cup	\cap	\supset	\subset	\supseteq	\subseteq	\varsubsetneq	\in	\notin	\boxplus	\boxminus	\boxtimes	\boxdiv	\boxdot
\wedge	\vee	\neg	\therefore	\because	\forall	\exists	\exists						
\leftarrow	\rightarrow	\uparrow	\downarrow	\leftrightarrow	\dashv	\vdash	\Rightarrow	\Uparrow	\Downarrow	\Leftrightarrow	\hookrightarrow		
\Re	\Im	\otimes	\otimes	\ll	\gg	\cdot	\dagger	\ddagger	\S	\S	\S	\S	\S

MathWriterTM

MATHEMATICAL TYPESETTING
with the MACINTOSHTM



J. Robert Cooke and E. Ted Sobel

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MathWriterTM

MATHEMATICAL TYPESETTING
WITH THE MACINTOSHTM

J.R. Cooke and E.T. Sobel
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Ithaca, New York

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MathWriter™

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Chapter One reviews the scope of MathWriter capabilities.

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Before using MathWriter read Chapter Two for advice about backup and user-interface conventions. A quick-start guide with three examples covers the basics. Additional examples illustrate each major feature of MathWriter.

3. MathWriter™ Command Reference 39

Chapter Three describes in detail the use of each option in the pull-down menus and each command of the on-screen palette in detail.

4. Appendices 87

The Appendices contain miscellaneous reference materials: instructions for using Switcher, sample output using various fonts, a form for making suggestions and reporting problems, a list of other Cooke Publications titles, and an order form.

5. Index 101

In addition to the usual alphabetical listing of topics, the Index provides a pictorial “table of contents” of the pull-down menus and on-screen palette, and keyboard command equivalents.

Preface

MathWriter™ grew out of a need to typeset the theory chapter for the finite element programs we were developing. The mouse-supported graphics environment of the Macintosh provides an excellent foundation for the development of a tool to support this otherwise tedious aspect of desktop publishing. MathWriter meets our needs, and we hope you also find it to be a suitable tool for the expression of your own ideas.

This is a completely new application which will surely evolve. We welcome your help in identifying "opportunities" for improvement. Our most immediate task will be to create a companion utility which will transform MathWriter data files into source code for the widely used $\text{T}_\text{E}\text{X}$ language. Because the software is more easily updated than the associated book, consult the "Read Me" file for the most recent information.

The creation of MathWriter has been a stimulating and exciting experience for us. Cornell University functioned in its best tradition by providing a supportive environment for creative expression in a non-traditional area of scholarly endeavor. An enlightened policy that regards intellectual property rights for software as basically the same as those for textbooks will surely encourage the creation of the tools needed by the next generation of scholars.

MathWriter's existence can be traced to the leadership of Vice Provost Kenneth King in nurturing the computing revolution at Cornell. Similarly, MathWriter's existence is a tribute to the integrated hardware and software system known as the Macintosh. Numerous individuals have contributed to the development of MathWriter; we particularly thank those listed on the credits page. MathWriter is a more finely honed tool because of their interest and shared experience.

We welcome your suggestions for features to be included in the next version of MathWriter. Let us know of your experience with MathWriter.

JRC, ETS
Ithaca, NY
September 1986

Introduction to MathWriter™ Capabilities

full screen editor

MathWriter™ is an **intelligent full screen editor for mathematical typesetting**. Unlike conventional word processors that deal with a one dimensional stream of characters on each line of text, MathWriter handles the two-dimensional characteristic of mathematical equations and offers you *convenient* access to a much larger collection of fonts, font styles, font sizes, and special mathematical symbols needed to write equations. Mathwriter automatically and interactively handles many typographic conventions such as placement of multiple levels of subscripts; placement and sizing of fraction bars; placement and sizing of the limits of integration; and stretching of brackets, braces, and parentheses to correspond to the size of their contents.

wysiwyg

MathWriter is a **“what you see is what you get”** editor. What you see on the screen as you type is what you get when you print the equation. You do not have to memorize a large collection of embedded commands that the program later converts into a screen display or printed output. The mouse and the user-customized palette on the screen permit you to compose even the most complex mathematical expressions with almost no use of memorized keystroke combinations. Simply **point-and-click**. This feature *dramatically* reduces the time required to master and to use this program!

user interface

MathWriter follows the **Macintosh™ User Interface** conventions. A Macintosh user already familiar with programs such as MacWrite™, MacPaint™, MacDraw™, or Microsoft Word™ will be comfortable with the familiar style of MathWriter™. Editing by pointing and dragging plus the “cut”, “copy”, and “paste” capabilities of MacWrite or Word™ appear the same. The single characters in MacWrite may in MathWriter be a complex vertical

structure such as a fraction bar with numerator and denominator, yet you can select, modify, and “cut and paste” these vertical components. You can even change fonts, font sizes, font styles, and special mathematical formatting preferences for existing text that you select by dragging the cursor.

output

The program fully supports both **ImageWriter™** and **LaserWriter™ printed output** with 72 and 300 dots per inch resolution respectively. The presently available Laser fonts are underlined in the menu listing for convenient identification. MathWriter stores the text internally in an expandable object form; therefore, the print resolution is limited only by the output device. The same file that produces a printed page on an ImageWriter can be used with Allied Linotype's Linotron that can produce 2570 dots per inch.

data storage

External storage of data in a MathWriter file allows you to retrieve and modify equations at a later time. You can store multiple equations in each MathWriter file. Each equation has its own vertical and horizontal tab information and font environment. Alternatively, you can internally convert each equation and store it on diskette in MacPaint and MacDraw (PICT) files to modify later with those programs; for example, you can place a box around an equation for emphasis. From these files you can transfer equations to page layout programs such as PageMaker™, or you can transfer them directly into these or other applications through the standard Clipboard. Switcher™, included with the program, allows immediate switching between different applications. You can compose equations as needed and immediately paste them into MacWrite or Word, or you can prepare many equations at



MW file

style



once and retrieve them as needed. MathWriter has a virtual memory scheme that allows you to handle files of equations larger than will fit in memory with only a slight delay for disk access.

MathWriter is flexible enough to deal with such **stylistic matters** as bracket overhang, subscript and superscript placement, spacing around the fraction bar, and the row and column spacing of elements within a matrix.

You can

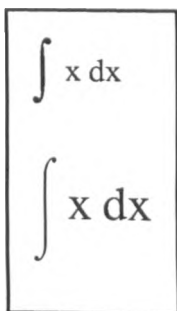
- locally lengthen or shorten parts of an expression.
- lengthen or shorten spacing between words to justify a line of text mixed with equations with a ruler in a word processor.
- arbitrarily increase or decrease the height of individual symbols.
- center matrices on a line or lower them below the line.
- align the rows in separate matrices with one another.
- vertically stretch or shrink certain symbols such as the integral symbol or the absolute value symbol as an override to the automatic sizing.
- stretch or shrink the equation to fit the available space while maintaining the width-to-height ratio even after you paste an equation into a MacWrite, Word, or WriteNow document.

$$[D] = \frac{E(1-\mu)}{(1+\mu)(1-2\mu)} \begin{bmatrix} 1 & \frac{\mu}{1-\mu} & 0 \\ \frac{\mu}{1-\mu} & 1 & 0 \\ \frac{\mu}{1-\mu} & \frac{\mu}{1-\mu} & 0 \\ 0 & 0 & \frac{1-2\mu}{2(1-\mu)} \end{bmatrix}$$



Further, more **complex placement of characters** is possible. For example, with an overlay screen you can manually handle superposition of multiple characters for closed contour integral symbols or for programming languages such as APL. You have the full complement of diacritical marks in a Laser font and an optional manual adjustment of vertical placement.

MathWriter offers numerous **typing aids**. The most significant is the on-screen palette menu that includes the Greek alphabet and some of the most common mathematical structures. You can interactively add to the on-screen palette from the pull-down palette menu a *user-selected* alphabet and any of the symbols in the Symbol™ LaserWriter™ font plus a few unique additions. This *user-defined* palette menu minimizes screen clutter by allowing you to transfer into the on-screen palette only those character groups you use most often. From a special pull-down menu you can click-type the trigonometric and hyperbolic function names.



The placement of a numerals palette on-screen enables you to create and recall rapidly up to ten user-defined expressions called “library scraps”. When used with the Option and Command (⌘) keys on the keyboard, the numerals entry palette provides access to these user-defined “library scraps”. Thus for quick pasting into expressions you can create frequently used groups of symbols as user-defined macros.

MathWriter™ User's Guide

MATHWRITER USER'S GUIDE

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MathWriter™ User's Guide

2.1 A QUICK START

2.1.1 Macintosh Conventions

The User's Guide consists of two parts: a quick start introduction which you should read before you begin use of the program and a more extensive guide to the operation of MathWriter which should give you a familiarity with all of MathWriter's powerful features. Chapter Three provides a detailed description of each tool for reference. We urge you to read the reference material at least once.

We assume that you are familiar with the Macintosh computer and either the MacWrite™ or Microsoft Word™ word processor. This User's Guide presumes such experience as background! (Experience with MacPaint, FullPaint, MacDraw, or MacDraft is useful but not a prerequisite for effective use of MathWriter.) While MathWriter can be a stand-alone application, it is more useful when used in combination with a word processor and Switcher™. Switcher is included with the master (distribution) diskette.

Throughout MathWriter we have adhered faithfully to the Macintosh User Interface. This allows you to concentrate more comfortably on the content of your work rather than on the vehicle used to produce the mathematical typesetting. As you type, the program continuously updates the displayed mathematical structures.

Flexibility is another feature of MathWriter. Multiple paths through the typesetting process allow you to proceed in the most comfortable and intuitive manner possible. At any stage all permissible options in a menu appear in normal print while non-permissible options appear dimmed and disabled.

In the discussion that follows we briefly review some of the most important Macintosh topics. The basic

Select Then Issue Command

assumption of the Macintosh interface is that language-independent pictures are a more convenient means of communicating than words. The use of pictures is facilitated by the "mouse" pointing device. Consequently, *the central paradigm for the Macintosh is for you to select an object by pointing and then issue an action instruction for the selected object.* Remember this and your mastery of this application will come more quickly.

Regard your Macintosh screen as an electronic representation of your desktop. You can rearrange the items on the screen with three basic actions of the mouse:

- 1) clicking** — Position the pointer (of whatever shape) to the desired location by moving the mouse, and then briefly press and release the mouse button without moving the mouse. Double-clicking in quick succession extends the action of the first click, e.g. to select *and* open a file.
- 2) pressing** — After positioning the pointer, hold down the mouse button without moving the mouse.
- 3) dragging** — Position the pointer, hold down the mouse button while moving the mouse to a new location, and release the button.

Cursor Shape

The *cursor shape* changes according to its function. An arrow is the most common shape and is used to press the scroll bars, the close box, etc. An I-beam pointer indicates the placement of text entered from the keyboard. A tiny "point" or dot cursor is used for very precise placement of the insertion point in a complex equation. A wrist watch pointer indicates that a time-consuming operation is in progress.

Select

You must *select* an object before you can perform an operation on it, but selection itself has no effect on the object and can be undone without side effects. Simply place the cursor on an object and click to select. Double clicking (clicking twice in succession without moving the mouse) extends the effect of a single click. For example, double clicking on an icon not only selects that item but also instructs the program to run or execute that item from the Finder.

You can select text and numeric entries by dragging. Simply place the pointer and click the mouse to fix the insertion point. The I-beam pointer automatically appears enabling you to insert characters. To remove characters, select them by dragging and press *Backspace* or begin typing to delete the selected material and insert new characters.

If the preceding was not a review, study your owner's guide and word processor manual. Review techniques for using the mouse, selecting and choosing, manipulating windows, using an application, and organizing documents.

In this User's Guide the **general instructions are in boldface text**, and the detailed *step-by-step procedures* are preceded by a bullet (•). The names of pull-down menus are shown in **bold**, the names of options on these menus are shown in *italic*, and the names of keys to be pressed are shown with leading capital and italicized. Buttons and menu choices are shown in capitals and italicized.

2.1.2 Backup Copy

Make a backup (working) copy of the distribution diskette immediately and add a copy of your word processor program to this working disk if double-sided (800K) or to a separate data disk if single-sided (400K).

- **Secure the write-protect tab of the master distribution disk to prevent accidental erasure** and locate an erasable diskette to become the working disk.

The working diskette should **not** be write-protected during the copy process **or** during actual usage. You can use up to 80K of the program disk space for temporary storage.

- Copy the entire **locked** master MathWriter diskette (System folder, MathWriter, and Switcher) to your working disk using the standard techniques.

To do this start your Macintosh and place your locked MathWriter disk in the internal drive. When the MathWriter diskette icon appears on the desktop, place the blank, destination diskette for the working copy in the external drive. [See "copying, disk" in your owner's manual if you are copying with a single drive.] If you have not previously used the destination disk, select *Initialize* and when requested supply a unique name (e.g., MW 9/1/86) for the working disk. On the other hand, if your destination disk has been used and contains other programs, either transfer these programs to another disk or erase the disk using the *Erase* option on the pull-down **Special** menu.

To start the copy process drag the master distribution disk icon to overlap the working disk icon. The master is NOT copy protected and requires no special procedures. When the copying is complete, use the *Shut down* option under the Special pull - down menu.

Now **store the master disk** in a safe place and place the working disk in the *internal* drive.

- Although not necessary for this quick introduction, transfer a copy of your word processor (e.g., MacWrite, Word, or WriteNow) to the working disk if it is double-sided (800K) or to a separate data disk if you are using single-sided disks.

If using double-sided disks place your word processor disk in the *external* drive. When the disk icon appears, click on it to open it. Then drag your word processor's icon onto the working disk. Eject the word processor disk using Eject on the **File** menu or alternatively use ⌘shift 2 (i.e., press and hold down the command (⌘) and shift keys while you press the numeral 2). With single-sided disks, the word processor *and* your data files will normally be in the external drive.

2.1.3 Introductory Examples

Activate the MathWriter application

- Open the MathWriter (working copy) disk by clicking on its icon.

The files on this disk are now displayed on the desktop.

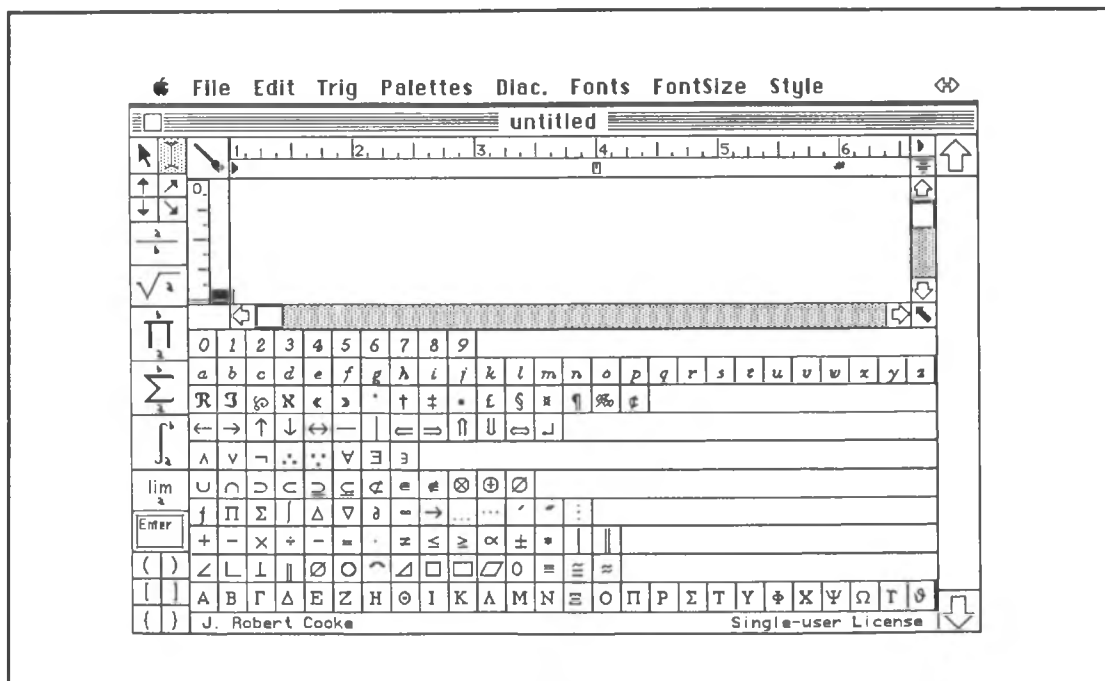
- Double click the MathWriter icon (or click once on the MathWriter icon and then select *Open* from the **File** menu).



MathWriter™

You use a slightly different procedure in the next section when you use Switcher to place both MathWriter and your word processor in memory at the same time. That additional complexity is not necessary for this quick tour.

The following screen is now present.



Explore some of the commands

- Pull down the menu, drag the cursor to **About MathWriter™**, and release the mouse button to see the copyright notice and MathWriter version number.
- Click anywhere within the banner to resume.

Produce the following three simple equations using the commands at the top left of the MathWriter screen. These examples show the basics of equation writing with MathWriter.

Example 1. Superscripts

Example 1: Enter an equation to illustrate the use of superscripts.

Enter the quadratic equation:

$$y = a x^2 + b x + c$$

Type: y
Space
=
Space
a
Space
x

Click: 

Type: 2
Enter

(Return works too, but *Enter* is preferred for leaving this superscript level. *Return* returns you to the base line even if the cursor is nested several levels deep as when you are typing a subscript of a subscript, but *Enter* removes only one level of nesting.)

The program automatically sets the superscript placement and font size.

$$y = a x^2 + b x + c$$

The screen should now contain the following: $y = a x^2$
If not, use *Backspace* to remove unwanted characters. The *Undo* option on the **File** menu is also convenient for this purpose. If you become hopelessly confused while typing an equation, use *Clear Equation* on the **Edit** menu to start again with a clean screen.



$$y = a x^2 + b x + c$$

- Complete the equation $y = a x^2 + b x + c$

Type: *Space*

+

Space

b

Space

x

Space

+

Space

c

Explore the edit commands.

- Place the I-beam cursor between the terms of the equation and insert additional spaces.
- Next select the x^2 term by dragging.
- Press the *Backspace* key to delete the term.
- Undo the last deletion. (Use ⌘ Z or pull down the **Edit** menu, drag to *Undo*, and release to restore the equation.)
- Replace the x^2 term with x^4

Select x^2 and press *Backspace* again. Without moving the cursor

Type: x



4

Enter

The display now contains:

$$y = a x^4 + b x + c$$

Save this polynomial equation on a data disk.

- Place a data diskette in the external drive if it is not already there.

Recall that if a single-sided disk is in the external drive, equation files such as you are now creating and your word processor share that disk space.

- Pull down the **File** menu, drag to *Save as...*, and release the mouse button.
- Supply a file name (e.g., Exercise 1), and click *Save* or press *Return*.

You have created a MathWriter data file identified with the following icon:



Exercise 1

This file saves all equations entered and the special formatting and set up information required to return you to the present configuration. To verify this, select *Clear Equation* from the **Edit** menu to clear this “equation page”. (You can save multiple equation pages in a single MathWriter data file described below.)

Saving Multiple Equation Pages in a Single Data File

- Select *Open...* from the **File** menu to open (or access) the data file you saved above.

The three dots after *Open...* indicate that you must supply additional information to complete the command. Specifically, you need to select the MathWriter file from the list presented in the window. If other MathWriter files were on the disk, you could scroll through the list to click-select the file you wanted to open.

- Select and open the file you saved (e.g., "Exercise 1") by double-clicking on the file name.

The equation you saved is now on the screen.

$$y = a x^4 + b x + c$$

- Make a copy of the current screen by pressing *Shift* ⌘ 3 (i.e., while holding down the *Shift* and ⌘ keys, press the numeral 3).

This produces a MacPaint file containing an image of the screen. The program stores the file with the name "Screen 0" on the system disk since this is the first such snapshot. You can create up to ten (0,1,...9) screens this way, and the number is automatically incremented; you must rename these files or place them in a folder if you wish to create additional screens using this technique.

Example 2. Adjusting Fraction Bars

Example 2 : Add another equation page and enter an equation to demonstrate subscripts and automatically sized fraction bars.

- Pull down the **Edit** menu and select *Insert after*.
(Alternatively, with *Option* pressed, click in the large arrow at the bottom right corner of the screen.)

The larger scroll bar at the far right of the screen now displays a 2 in the scroll box indicating that the current display screen corresponds to equation page 2. Now enter an open loop transfer function (D'Azzo and Houpis 1966, 185) from feedback control theory.

$$G(s) = \frac{K_2}{s^2 (1 + T_f s)(1 + T_m s)}$$

- Enter the left hand side of the equation using the techniques of example 1.

Type: $G(s) =$

- Click on the fraction icon



(Note: You enter the numerator of the fraction before you enter the denominator.)

Type: K



2

Enter

Enter

(Back to the depth of K.)

(NOT Return)

Your equation should look like this:

$$G(s) = \frac{K_2}{s^2(1 + T_f s)(1 + T_m s)}$$

$$G(s) = \frac{K_2}{s^2(1 + T_f s)(1 + T_m s)}$$

Enter moves the cursor to the denominator, but *Return* moves the cursor back to the depth of the equals sign. Note that the fraction bar is drawn automatically and the length adjusts interactively to match the length of the numerator. When you enter the denominator, the program centers it; if the denominator length exceeds the numerator length, the program extends the fraction bar length and centers the numerator interactively.

Type: s



2

Enter (back to the depth of the s)

(1 + T



f

Enter (back to the depth of T)

s)(1 + T



m

Enter (back to depth of T)

s)

Enter (back to = depth;
Return would also work)

The screen should resemble this:

$$G(s) = \frac{K_2}{s^2 (1 + T_f s)(1 + T_m s)}$$

If not, use the standard edit techniques to correct characters on the base line as you would with the usual word processor techniques. To edit characters at any other depth you must use the arrow icon at the top left of the screen to obtain the "point" insertion point.

When you press the point cursor within the mathematical structure, the selected substructure is highlighted; when you release the mouse button, the insertion point is a tiny point to the right of the previously highlighted substructure.

Example 3.
Parentheses Adjust
Automatically

Example 3: Add a third equation page and enter an equation to show that parentheses automatically adjust in size as the context requires and that an expression may have both subscripts and superscripts.

- Pull down the **Edit** menu and select *Insert after*.

Enter an equation from thermodynamics (Zemansky 1968, 293)

$$C_P - C_V = -T \left(\frac{\partial V}{\partial T} \right)_P^2 \left(\frac{\partial P}{\partial V} \right)_T$$

$$C_P - C_V = -T \left(\frac{\partial V}{\partial T} \right)_P^2 \left(\frac{\partial P}{\partial V} \right)_T$$

Type: C



P

Enter

Space

—

Space

C



V

Enter

Space

=

Space

—

Space

T

(

(from palette or keyboard)



(The parenthesis adjusts in size when you select the fraction icon.)

∂

(from **Palette** menu)

V

Enter

∂T

Return

)

(The closing parenthesis also automatically adjusts to an appropriate size.)



2

Enter

P

(A symbol may have both a subscript and a superscript.)

Return

Now the screen shows:

$$C_P - C_V = -T \left(\frac{\partial V}{\partial T} \right)_P^2$$

(Note: The screen image of the left and right parentheses may not appear to have the same height, but the printed output will be correct. This appears to be due to the screen font; the braces and brackets do not exhibit this quirk. See section 27.0 of the Reference Guide (Chapter 3) for instructions to manually adjust the vertical dimension of certain tall characters.)

$$C_P - C_V = -T \left(\frac{\partial V}{\partial T} \right)_P \left(\frac{\partial P}{\partial V} \right)_T$$

(

 ∂P *Enter* ∂V

)



T

Return

The screen shows:

$$C_P - C_V = -T \left(\frac{\partial V}{\partial T} \right)_P^2 \left(\frac{\partial P}{\partial V} \right)_T$$

- Click in the equation page scroll arrows to review the equations.

Equation scroll arrows



Equation page number

- Save the equations in a MathWriter file using *Save* on the **File** menu.

The program saves these equations using the default file name, drive, folder, etc. established in the previous *Save as....* You can also save *the* currently displayed equation page as a MacPaint and as a MacDraw (PICT) file using the **File** menu. (However, such files can only be further modified using those applications. Only MathWriter data files which retain the complete configuration information may be further modified by MathWriter. You may save in multiple formats, however.)

- Choose *Close* from the **Edit** menu to close this data file; then you can use *New* or *Open...* to begin with a new file.
- Select *Quit* to terminate the MathWriter session and to return to the Finder at the desktop.

You now see how to handle the typesetting for many of the equations from algebra, trigonometry, and calculus. Already the utility of the immediate visual display of your commands and the power of pointing and clicking rather than memorizing and typing is apparent. We suggest that you practice with the following equations before proceeding to the discussion of the more advanced features of the next section.

2.1.4 Practice examples

Test your skills with these practice problems.

Example 4:

$$W = b_0 + b_g P_g + b_s P_s$$

From: Cooke, J.R. et al. 1976. "A finite element analysis of guard cell deformations". ASAE Transactions 19(6):1107-1121.

Example 5:

$$G_2 = f^2 m^{2/3} \rho_2^{1/3} CR$$

From: Cooke, J.R. 1972. "An interpretation of the resonant behavior of intact fruits and vegetables". ASAE Transactions 15(6):1075-1080.

Example 6:

$$R = R_b + R_s = (a/D) \{ T + [\beta^2 \ln(4/\alpha) + L_p \beta^2 / \alpha - \beta] \}$$

From: Cooke, J.R. and R.H. Rand. 1980. "Diffusion resistance models"
Ch5 in *Predicting Photosynthesis for Ecosystem Models*. Hesketh, J.D.
and J.W. Jones (ed) CRC Press 1:93-121.

Example 7:

$$(a_1 + a_2 \omega^2)^2 - (a_3 \omega^2 - a_4)(a_5 \omega^2 - a_6) = 0$$

where

$$a_1 = K$$

$$a_2 = M R L$$

$$a_3 = [(\mu/3) + M] L^2$$

$$a_4 = S + K + [(\mu/2) + M] g L$$

$$a_5 = (7/5) M R^2$$

$$a_6 = M g R + K$$

Use *Return* to begin new lines. Use horizontal tabs (See section 24.0 of Reference Guide) to align equals signs. Use the vertical tabs (section 25.0 of Reference Guide) to adjust the spacing between rows of equations.

From: Cooke, J. R. and R.H. Rand. 1969. "Vibratory fruit harvesting: A linear theory of fruit-stem dynamics." *Journal of Agric. Engineering Research* 143:195-209.

Example 8:

$$V = [2\pi/3] [a / \sin \theta]^3 [3 \sin \theta + 3 (\pi - \theta) \cos \theta - \sin^3 \theta],$$

where

$$W/H = \begin{cases} (1 + \cos \theta) , & 1 < W/H \leq 2 \\ (1 + \cos \theta) / \sin \theta , & 0 < W/H \leq 1 \end{cases}$$

Use the **Trig** menu to enter the trigonometric functions (section 4.0 of Reference Guide). Use the Greek alphabet at the bottom of the screen for θ and π . The brace may be entered from the palette or keyboard and stretched to size (section 27.0 of Reference Guide).

From: Cooke, J. R. and R.H. Rand. 1969. "Vibratory fruit harvesting: A linear theory of fruit-stem dynamics." Journal of Agric. Engineering Research 143:195-209.

Example 9:

$$x = \cos \theta \{B + A C [1 + \sin \phi] [(A \cos \theta)^2 + (B \sin \theta)^2]^{-(1/2)}\}$$

$$y = \sin \theta \{A + B C [1 + \sin \phi] [(A \cos \theta)^2 + (B \sin \theta)^2]^{-(1/2)}\}$$

$$z = D \cos \phi$$

$$\text{where } 0 \leq \theta \leq \pi/2, -\pi/2 \leq \phi \leq \pi/2$$

From: Cooke, J.R. et al. 1976. "A finite element analysis of guard cell deformations". ASAE Transactions 19(6):1107-1121.

Example 10:

$$\begin{aligned} & [(\mu/3) + M] L^2 \ddot{\theta} + M L R \ddot{\phi} + S \theta + K (\theta - \phi) + [(\mu/2) + M] g L \theta = \\ & (7/5) M R^2 \ddot{\phi} + M L R \ddot{\theta} + K (\phi - \theta) + M g R \phi = 0 \\ & (2/5) M R^2 \ddot{\psi} + C \psi = 0 \end{aligned}$$

Use the **Diac.** menu to place the double dots for the second derivatives (section 6.0 of Reference Guide). Use the *Raise* and *Lower* options to adjust the vertical spacing.

From: Cooke, J. R. and R.H. Rand. 1969. "Vibratory fruit harvesting: A linear theory of fruit-stem dynamics." Journal of Agric. Engineering Research 143:195-209.

Example 11:

$$\frac{d^2 y}{dt^2} + [D_0 - D_1 a \Omega^2 \cos \Omega t] y = 0$$

From: From: Cooke, J. R. and R.H. Rand. 1969. "Vibratory fruit harvesting: A linear theory of fruit-stem dynamics." Journal of Agric. Engineering Research 143:195-209.

Example 12:

$$\frac{d}{dt} \left(\frac{\partial T}{\partial \dot{q}_k} \right) - \frac{\partial T}{\partial q_k} = Q_k$$

$$k = 1, \dots, n$$

From: Cooke, J.R. and J.W. Dickens. 1971. "A centrifugal gun for impaction testing of seeds". ASAE Transactions 14(1):147-155.

Example 13:

$$\dot{r} = \left\{ \left[\frac{2 H_r}{m} + r^2 \omega^2 \right] \left[\frac{5}{7} \left(1 - \frac{p^2}{r^2} \right) \right] \right\}^{1/2}$$

Watch the braces, brackets, and parentheses re-size automatically as you enter the equation.

From: Cooke, J.R. and J.W. Dickens. 1971. "A centrifugal gun for impact testing of seeds". ASAE Transactions 14(1):147-155.

Example 14:

$$u(z, t) = T_{av} + B \exp[i(\omega t - \zeta z)]$$

$$v(r, z, t) = T_{av} + A H_0^{(1)}(x) \exp[i(\omega t - \zeta z)]$$

$$\text{where } \beta = \alpha \sqrt{(\varphi / \alpha_s)}$$

$$\lambda = V_a / \omega$$

$$\gamma = (m_a' c_a' \omega_a) / k_s$$

$$N_{Bi} = (h a / k_s)$$

$$B = A \left[H_0^{(1)}(\beta) - \frac{\beta i^{3/2}}{N_{Bi}} H_1^{(1)}(\beta) \right]$$

$$\zeta = \frac{1}{\lambda} + \sqrt{i} \left[\frac{\lambda \gamma}{\beta} \left(\frac{H_0^{(1)}(\beta)}{H_1^{(1)}(\beta)} + \frac{\beta i^{3/2}}{N_{Bi}} \right) \right]^{-1}$$

From: Scott, N.R. et al. 1982. "Analysis of earth-air heat exchange". Lawrence Berkley Laboratory Report. 72 pages.

Example 15:

Use symbols with both subscripts and superscripts (Ch 3, section 11.0), fractions (12.0), parentheses and braces (19.0 and 27.0), and vertical tabs (19.0).

$$\begin{aligned}
 S &= \omega (G_{\xi\xi\eta} + G_{\eta\eta\eta}) + G_{\xi\eta} (G_{\xi\xi} + G_{\eta\eta}) \\
 &= \frac{k_2(k_1^2 + k_2^2) c_1^2}{(1 + k_3)^6} \left\{ \frac{6(1+k_3)^2}{c_1} + \frac{4 k_1}{\omega^2} \right\}
 \end{aligned}$$

From: Rand, R.H. et al. 1981. "Hopf bifurcation in a stomatal oscillator". *Journal Math. Biology.* 12:1-11.

Example 16:

In this practice problem you repeatedly use a symbol ∂ from the **Palettes** menu, so place the *Math/Calculus* symbols on the screen (5.0) and save the subscripted symbols in the library of scraps.(3.13, 5.0).

$$\begin{aligned}
 \rho \left(\frac{\partial v_r}{\partial t} + v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_r}{\partial \theta} - \frac{v_\theta^2}{r} + v_z \frac{\partial v_r}{\partial z} \right) &= - \frac{\partial p}{\partial r} \\
 + \left[\frac{\partial}{\partial r} \left(\frac{1}{r} \frac{\partial}{\partial r} (r v_r) \right) + \frac{1}{r^2} \frac{\partial^2 v_r}{\partial \theta^2} - \frac{2}{r^2} \frac{\partial v_\theta}{\partial \theta} + \frac{\partial^2 v_r}{\partial z^2} \right] &+ \rho g_r
 \end{aligned}$$

From: Bird, R.B. et al. 1960. *Transport Phenomena*. John Wiley and Sons. New York. p85.

Example 17:

Use Greek alphabet (20.0), vectors and matrices (19.0), diacritical marks with spacing adjustment (6.0), bracket overhang adjustment (9.9.1), alignment of matrix rows (9.10), matrix centering (9.11), horizontal tabs (24.0), and vertical tabs (25.0).

$$\xi_1 \begin{Bmatrix} \dot{P}_g \\ \dot{P}_s \end{Bmatrix} = \begin{bmatrix} b_1 & b_2 \\ b_5 & b_6 \end{bmatrix} \begin{Bmatrix} P_g \\ P_s \end{Bmatrix} + \begin{Bmatrix} b_3(t) \\ b_8(t) \end{Bmatrix} + \begin{Bmatrix} b_4 \\ b_9 \end{Bmatrix} + \begin{Bmatrix} 0 \\ g_1 \end{Bmatrix}$$

$$\text{where } \xi_1 = \frac{2 V_g^0}{L \epsilon_g A_2}$$

$$b_1 = -[1 + (\pi_g^0 / \epsilon_g)]$$

$$b_2 = [1 + (\pi_g^0 / \epsilon_s)]$$

$$b_3(t) = \tilde{\pi}_g$$

$$b_4 = (\pi_g^0 - \pi_s^0)$$

$$b_5 = \epsilon V [1 + (\pi_g^0 / \epsilon_g)]$$

$$b_6 = -(\epsilon V + 2 \epsilon A V) [1 + (\pi_s^0 / \epsilon_s)]$$

$$b_8(t) = -\epsilon V \tilde{\pi}_g$$

$$b_9 = \epsilon V (\pi_s^0 - \pi_g^0) + 2 \epsilon A V (\psi_r + \pi_s^0)$$

$$g_1 = \frac{-2 \epsilon A V R_p}{R_t} (c_m - c_{ta})$$

From: Delwiche, M.J. and J. R. Cooke 1977. "An analytical model of the hydraulic aspects of stomatal dynamics" *Journal of Theoretical Biology*. 69:113-141.

Example 18:

Use style (9.2), vectors and matrices (19.0), horizontal tabs (24.0), vertical tabs (25.0), manual symbol size adjustment (27.0), diacritical marks (6.0), and center matrix (9.11).

$$\mathbf{A} \ddot{\mathbf{x}} + \mathbf{B} \dot{\mathbf{x}} = \mathbf{v}$$

where

$$\mathbf{x} = \begin{bmatrix} \theta \\ \phi \end{bmatrix}$$

$$\mathbf{A} = \begin{bmatrix} \left(\frac{\mu}{3} + M \right) L^2 & MLR \\ MLR & \frac{7}{5} M R^2 \end{bmatrix}$$

$$\mathbf{B} = \begin{bmatrix} S + K + \left(\frac{\mu L}{2} + ML \right) (g + \ddot{\eta}) & -K \\ -K & K + M R (g + \ddot{\eta}) \end{bmatrix}$$

$$\mathbf{v} = \begin{bmatrix} - \left(\frac{\mu L}{2} + M L \right) \ddot{\xi} \\ - M R \ddot{\xi} \end{bmatrix}$$

From: Rand, R.H. and J.R. Cooke. 1970. "Vibratory fruit harvesting: A non-linear theory of fruit-stem dynamics". Journal of Agric. Engineering Research. 15(4) 347-363.

Example 19:

Use the summation symbol (15.0). Click the summation icon. The program positions the cursor for the lower limit and reduces the font size. The lower limit can be an arbitrarily complex expression. Press *Enter* to move from the lower to the upper limit. Use the **Palettes** menu (5.0) to enter the symbol for infinity. After entering the upper limit, press *Enter* again to type the expression for the terms of the series.

$$\phi(r,t) = T_w + \frac{2(T_w - T_0)}{r} (r_0) \sum_{n=1}^{\infty} \frac{(-1)^n}{n} e^{-\lambda_n t} \sin [(n \pi / r_0) r]$$

$$V_r(x,t) = -\frac{k_4}{k_3} + \sum_{m=1,3,5,\dots}^{\infty} \frac{4 a_1}{m \pi} \exp (\mu_m t) \sin (\lambda_m x)$$

$$P(x,t) = \frac{-16 a_1 k_1 l^2}{\pi^3} \sum_{m=1,3,5,\dots}^{\infty} \mu_m \frac{\exp (\mu_m t)}{m^3} \sin (\lambda_m x)$$

From: Stroshine, R.L. et al. 1985. "An analysis of resistance to water flow through wheat and tall fescue leaves during pressure chamber efflux experiments" *Plant, Cell and Environment*. 8:7-18.

Example 20:

Use the integral icon (16.0). The program automatically positions the cursor and reduces the font size for the lower and upper limits of integration. Use *Enter* to move from the lower to upper limit and from the upper limit to the integrand. The integral symbol size may be manually adjusted (27.0) This example also introduces the square root symbol (13.0) which the program automatically sizes.

$$Q = \frac{2 \pi D C_0 a}{K(\epsilon)}$$

where

$$K(\epsilon) = \int_0^{\pi/2} \frac{d\phi}{\sqrt{(1-\epsilon^2 \sin^2 \phi)}}$$

and

$$\epsilon^2 = \frac{a^2 - b^2}{a^2}$$

From: Cooke, J.R. 1966. "Some theoretical considerations in stomatal diffusion: A field theory approach" *Acta Biotheoretica*. 173:95-124.

Example 21:

In this example explore the use of the on-screen alphabet and numeral palettes (5.0). Three terms recur in the equation, so create them and paste them into the library of scraps. We used *BodoniItalic* in this example. Save your work often when working either with new commands or with complex expressions (2.4, 2.5). Improve the appearance of the matrix expressions (9.10, 9.11).

$$\mu_c = \frac{1}{2} \int_0^{L_i} \left([f_i \quad m_i] \begin{bmatrix} \frac{y^2}{EI} + \frac{1}{K_s GA} & \frac{y}{EI} \\ \frac{y}{EI} & \frac{1}{EI} \end{bmatrix} \begin{Bmatrix} f_i \\ m_i \end{Bmatrix} \right) dy$$

From: Upadhyaya, S.K. et al. 1981. "Limb impact harvesting, Part I: Finite element analysis". Transactions ASAE. 24(4) 856-863.

Example 22:

The final exercise demonstrates the matrix alignment capabilities of MathWriter.

$$\begin{bmatrix} \frac{\partial \dot{u}_1}{\partial x_1} & \frac{\partial \dot{u}_1}{\partial x_2} \\ \frac{\partial \dot{u}_2}{\partial x_1} & \frac{\partial \dot{u}_2}{\partial x_2} \end{bmatrix} = \begin{bmatrix} \frac{\partial \dot{u}_1}{\partial x_1} & \frac{1}{2} \left(\frac{\partial \dot{u}_1}{\partial x_2} + \frac{\partial \dot{u}_2}{\partial x_1} \right) \\ \frac{1}{2} \left(\frac{\partial \dot{u}_2}{\partial x_1} + \frac{\partial \dot{u}_1}{\partial x_2} \right) & \frac{\partial \dot{u}_2}{\partial x_2} \end{bmatrix} - \begin{bmatrix} 0 & \frac{1}{2} \left(\frac{\partial \dot{u}_2}{\partial x_1} - \frac{\partial \dot{u}_1}{\partial x_2} \right) \\ \frac{1}{2} \left(\frac{\partial \dot{u}_1}{\partial x_2} - \frac{\partial \dot{u}_2}{\partial x_1} \right) & 0 \end{bmatrix}$$

From: Bathe, Klaus-Jurgen. 1982. *Finite Element Procedures in Engineering Analysis*. Prentice-Hall, Inc. Englewood Cliffs. p324.

MathWriter™ **Command Reference**

MATHWRITER COMMAND REFERENCE

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PULL-DOWN MENUS

🍏 File Edit Trig Palettes Diac. Fonts FontSize Style

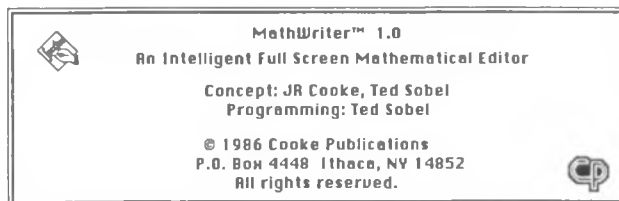


1.0 🍏 — the “Apple” menu

The first item in the 🍏 menu is always a description of the program you are currently using.



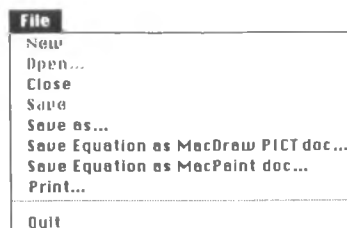
We present here the version identification and copyright notice for MathWriter™. MathWriter emerged from a need to typeset the mathematics for the Macintosh and the IBM PC instructional finite element analysis programs published by Cooke Publications. J. Robert Cooke and E. Ted Sobel formulated the conceptual basis for MathWriter™; E. Ted Sobel produced the Lisa Pascal code.



The remaining items on the “Apple” menu are desk accessories. Typical accessories include: Alarm Clock, Calculator, Chooser, Control Panel, Key Caps, and Scrapbook. You have access to these handy tools even while using MathWriter.

File**2.0 File**

The first five **File** items perform exactly the same file control functions they perform in MacWrite or Word. **File** controls access to the permanent mass storage provided by your disk drives.

**2.1 New**

Use this command to open a **new** untitled file. If a file is currently pending, you must use the third command *Close* to close it before beginning anew. After selecting *Close* you must decide whether to save the existing document if you have made any changes to the file. Notice that the *New* command dims when it is not usable.

2.2 Open...

This command **opens** an existing MathWriter file if no file is currently open. The ellipsis after the command indicates that you need to supply additional details in a dialog box. The standard Open... dialog box appears. Any MathWriter data files present on the disk are indicated as choices for selection. Use the standard procedures to select the *drive* which contains the file, to open a *folder*, to select the desired *file* by clicking on the file name, and then to retrieve the file by clicking the *open* button.

Pressing *Return* or double clicking on the file name also opens the file. If a file is currently open, the *Open* command remains dimmed until you *Close* that file.

2.3 Close

This command closes the active window and document if you have made no changes since the last *Save* command.

If you have made changes, MathWriter gives you an opportunity to save your file before the document disappears. When you close a file, MathWriter remains active and does not return you to the Finder. The *Close* command has the same effect as clicking the close box at the top left corner of the screen.

You can use *New* or *Open* to begin work with another document. To quickly leave the MathWriter application entirely, you can use the *Quit* command described below instead of *Close*.

2.4 Save

This command saves the current collection of equations as a MathWriter document on the currently active drive and folder. If you began with a *New* command, you must give the untitled document a file name via the dialog box. This title is displayed at the top of the screen. If you began with an existing file, the program replaces the earlier version of the file with the newer version without commentary. If you wish to preserve the old version as well as the new, use *Save as ...* and supply a different file name.

Save equations in file...

Maxwell's Equations

MathWriter has a unique icon to visually identify the files of pages of equations. Only Mathwriter can retrieve these files. The program stores all the formatting information needed to reactivate the file; if you use the special commands (in 2.6 and 2.7) to create MacPaint or MacDraw files, only those applications, not MathWriter, can further process their respective files as a result of the format changes.



2.5 Save as...

This command saves the document as a MathWriter file after you supply the file name, drive, and possibly the folder name. If you have second thoughts about saving, choose *Cancel*. The data you supplied becomes the default for the next *Save* command. Unlike some operating systems, spaces in file names are permitted. Do not use the *colon (:)*, *Tab*, or *Return* keys in the file name. Clicking a *Return* key is equivalent to clicking the *Save* button. If you give the file an existing file name, you are given an opportunity to choose a different name or to replace the existing document. Use the *Eject* button if you wish to change diskettes.

2.6 Save Equation as MacDraw PICT doc...


This command saves in MacDraw PICT format only *the* mathematical equation currently being displayed not the entire collection of equations. The file naming and drive selection considerations noted for the *Save as...* command

(2.5) also apply here. You can subsequently modify MacDraw files in MacDraw but not in MathWriter. If you are likely to require any subsequent equation modification, save the document also as a MathWriter file. PageMaker™ can directly open (*Place*) MathWriter equations saved in MacDraw (PICT) format.

2.7 Save Equation as MacPaint doc...

This command saves in MacPaint format only the mathematical equation currently being displayed, not the entire collection of equations. The file naming and drive selection considerations noted for the *Save as...* command above also apply here. You can modify MacPaint files later in MacPaint but not in MathWriter. Use this command in a two step method of delayed data transfer if you wish to paste an equation into another application too large to be simultaneously resident with MathWriter and Switcher. The equation will be saved at the top-left corner of the MacPaint screen so *Show Page* may be useful. If you are likely to require any subsequent equation modification in MathWriter, save the document also as a MathWriter file.

2.8 Print...

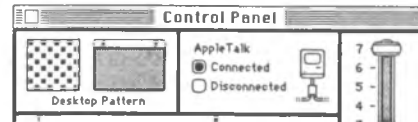
The *Print* command produces output with the ImageWriter and the LaserWriter. Consult your manual for hardware setup advice. If this is the first use of the output device since power-up, supply paper, activate the output device, and then use the *Control Panel* and *Chooser* options of the  menu to properly route the output.

AppleTalk

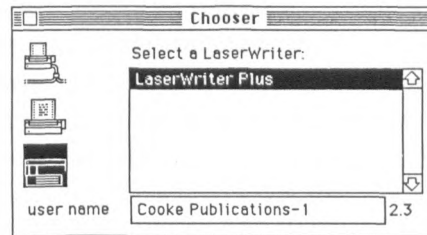
☒ Connected☐ Disconnected

Startup procedure:

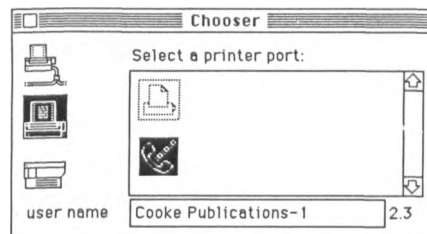
If your ImageWriter is connected to the printer port and is not connected via AppleTalk, click "Disconnected". On the other hand, the LaserWriter must be connected via AppleTalk, so click "Connected" on the *Control Panel* of the menu.



Use *Chooser* of the menu to select the output device and port. The LaserWriter Plus is shown selected, but a LaserWriter may also be used.



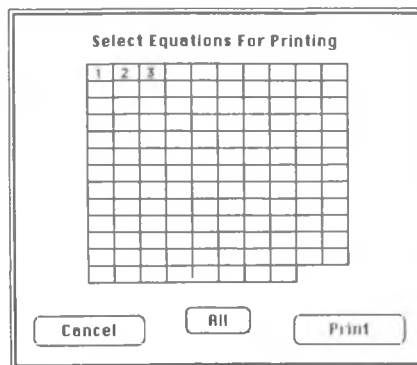
An ImageWriter connected to the modem port is shown selected.



After preparing the printer:

Select *Print...* from the **File** menu and then select the equations for printing.

Select by number the equations to be printed. In this example three equations exist. Select by clicking the equation numbers or select a range of numbers by clicking the beginning of a range and Shift-click the ending number. Alternatively, click the *All* button to select all equations. The rectangles of the selected equations are shown inversed.



Click the now-active *Print* button.

Equations may also be printed from the desktop using the Finder's *Print* option on the **File** menu, even when MathWriter is not currently active.

2.9 Quit

According to custom, the last **File** option is *Quit* and allows you to leave the application and return to the desktop. If you have made changes since the last file save, you have one last opportunity to save your document; the file naming and drive selection considerations noted for *Save as...* apply here.

Edit

Edit	
Undo	⌘Z
Cut	⌘H
Copy	⌘C
Paste	⌘V
Clear Equation	
Select All	
Copy to Clipboard	⌘K
Auto Copy	
Remove	
Insert before	
Insert after	
Overlay Symbols	
Show Scrap	
Show Clipboard	

3.0 Edit

The **Edit** commands provide the five text manipulation options available in MacWrite or Word plus many more. The shortcut keyboard command equivalents for *Undo*, *Cut*, *Copy*, and *Paste* are the same and are shown at the right of each command. The commands consist of a two key sequence; press and hold down the ⌘ key located between the Option key and Space bar while you press the second key.

3.1 Undo (⌘Z)

This “oops” command allows you to undo the last command for those actions for which the program has not dimmed the *Undo* command.

You can undo the following actions:

1. Cut
2. Backspace
 - a) a selected range of characters that you deleted by a backspace
 - b) sequences of single-character backspaces until you encounter another superscript/subscript level or until you take an action other than a backspace
3. Clear Equation
4. Paste
5. Remove
6. Font change for selected text
7. FontSize change for selected text
8. Style change for selected text
9. Preferences change for selected text
10. Movement of an overlay symbol up to last move

3.2 Cut (⌘ X)

This command removes selected portions of the equation. Drag to select portions of text then *Cut* to remove the selected text. The removed text goes into the **active scrap** replacing the current contents. That text remains in the active scrap, and you can paste it into another equation until you replace it by another *Cut* or *Copy*. As with all Macintosh commands, designate the object to be acted upon **before** you specify the action on the object. Consequently, the *Cut* option remains dim until you select the text to be cut.

You can view the text cut from the document using the *Show Scrap* command below. Use the *Paste* command described below to retrieve the material cut from the equation. Also see the *Copy to Clipboard* command described below for transfer of data between applications in either TEXT or PICT form.

3.3 Copy (⌘ C)

This command copies selected text to the active scrap. Select portions of text using the mouse; then use *Copy* to place a copy of the selected text in the active scrap. The copy remains in the scrap until you replace it with a subsequent *Cut* or *Copy*.

Use *Paste* to move the scrap contents to another location in the equation or into another equation. *Copy*, unlike *Cut*, does *not* remove the selected text from the original document.

[Use the special command *Copy to Clipboard* if you wish to copy the entire equation to the clipboard for transfer to another application.]

3.4 Paste (⌘ V)

[Note: *Copy* and *Paste* are adjacent.]

This command electronically pastes the contents of the active scrap into the current screen at the insertion point. *Paste* is enabled only when the active scrap is in use. You must define the insertion point or a range of selected text before executing the *Paste* command. After the program pastes the scrap contents, the insertion point moves to the end of the inserted text. When pasting into a selected range of text, you replace the selected text with the scrap.

3.5 Clear Equation

This command clears the entire screen, and that includes all parts, whether visible or not, of the current equation associated with the equation number shown in the larger scroll box at the far right. It does not affect other equations which you can view by using the larger scroll bar for equations. Note: This command even removes any existing Overlay symbols as well as everything except the horizontal tab markers associated with the equation. However, the equation page remains; use the *Remove* option (3.9 below) to clear and remove the page (and renumber all succeeding equation pages).

3.6 Select All

This command selects all entries, whether fully visible or not, on the entire current equation page except any text added using the *Overlay Symbol...* command below. You can use this command in conjunction with *Cut* and *Copy*. The *Copy to Clipboard* command below automatically performs the *Select All* function.

3.7 Copy to Clipboard (⌘K)

This command copies the entire contents of the current equation page to the clipboard. It automatically performs a *Select All* before the copy. Use *Copy to Clipboard* to transfer an equation to other applications such as MacWrite or Word. Use it in conjunction with Switcher™ for greater speed. Under certain conditions you may prefer to use the *Auto Copy* option described in 3.8.

Copy to Clipboard converts the equation in MathWriter form to the versatile Macintosh PICT format which is transferrable between Mac applications. Note that *Copy to Clipboard* copies parts of the equation not visible on the screen; it does not copy any indication of highlighting of selected characters (if any) or the blinking insertion point.

3.8 Auto Copy

Click the *Auto Copy* option to have the program automatically execute the *Copy to Clipboard* command when you leave the program via Switcher. A small check mark appears on the menu to indicate that this option is active. Click again to defeat this option.


When using MathWriter in a RAM limiting situation, e.g. with a word processor and Switcher on a 512K Mac or with WriteNow™, FullPaint™, and Switcher on a 1M Mac, you may choose to avoid use of this option for speed considerations.

3.9 Remove


Remove completely removes the equation page from the resident file and makes the immediately previous

equation page, if any, the current page. After page removal it rennumbers any higher numbered equation pages. If you wish to remove several equations and do not want their page numbers to change continually during the process, remove them in decreasing numerical order. The page numbers are relative not absolute.

3.10 Insert before

Insert before creates a new empty equation page and places it immediately *before* the currently displayed equation page. With this command and the equation scroll bar you can establish the storage ordering of equations regardless of entry order. This command may also be executed quickly by clicking the equation scroll arrow  while pressing the *Option* key.

3.11 Insert after

Insert after creates a new empty equation page and places it immediately *after* the currently displayed equation page. With this command and the equation scroll bar you can establish the storage ordering of equations regardless of entry order. As an alternative to menu access of this command, click  while pressing the *Option* key.

3.12 Overlay Symbols

Overlay Symbols permits arbitrary placement of characters on the screen including superimposing

multiple characters. You can use this command to write such things as the character set for APL programs and the symbol for closed contour integrals.

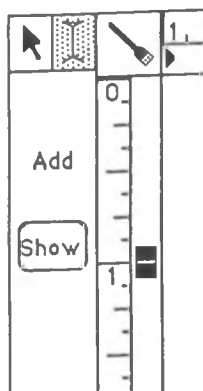
$$\oint F(s) ds$$

$$dW = \int \mathbf{F} \cdot d\mathbf{r}$$

The program replaces the left panel of the screen palette with the tools applicable for this mode. You automatically enter a special input mode indicated by the tiny “point” cursor. Establish the insertion point by clicking.

In general, use the *Overlay Symbols ONLY* after you have completed the rest of the equation.

In this mode you can arbitrarily position characters including overlaying one character with another. The program places characters with respect to the absolute coordinates of the screen, and these characters do not change position even if you subsequently modify those on the underlying main screen. Therefore, use this feature for its special capabilities *only* after you have completed the rest of the equation. The overlay and regular screen composite prints as a single screen.




The overlay screen is transparent; therefore, to identify the special characters created on the overlay screen in order to make fine adjustments in character alignment, use the *Show* command.

You can reposition any individual character on the overlay screen with the mouse. While depressing the

Option key, drag *individual* characters to the desired location with the mouse.

Note: In the program's data structures there is absolutely **no** relation between symbols on the overlay and normal text screens. Consequently updates in one screen do not automatically update the other screen also.

3.13 Show Scrap

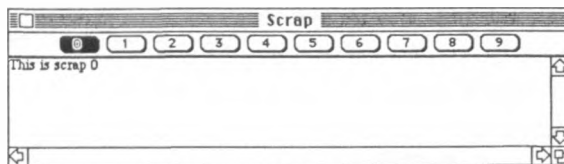
Show Scrap is a generalization of the *Scrapbook* desk accessory in the  menu. Because certain symbols such as variables with subscripts and superscripts frequently reappear within a single equation or within a sequence of equations in a derivation, construct and save such combinations at the outset to speed your typing. MathWriter provides 10 scrap files which are equivalent to 10 single keystroke macro commands. You have both keystroke and mouse command alternatives.

Keystroke

1. To place mathematical text into one of the scraps with the keystroke alternative, highlight the text you want to copy. Then copy the selected text into the designated scrap by simultaneously pressing the $\%$ key and one of the numerical keys (0-9). To retrieve the text, simply set the insertion point using the mouse; then with the $\%$ and *Option* keys simultaneously pressed, type the number corresponding to the scrap to be retrieved.

The *Numeric* palette from the **Palettes** menu discussed below gives you visual prompting. If activated, the numerical characters 0-9 on the palette show up in **outline** style to indicate which scraps are in use. Use the *Show Scrap* command to examine the actual contents of

any scrap. The program **outlines** those numerical buttons located at the top of the scrap window which correspond to the scraps in use. Click on an outlined numerical button to view the associated scrap in the small window. Scroll bars and a re-size box enable you to view the entire window.



Unless you need an added visual check to remind you of the contents of a specific scrap, the keystroke technique is probably a more convenient way to store and retrieve scraps than the mouse and pull-down menu.

Mouse

2. To place mathematical text into one of the scraps with the menu alternative, first highlight the selected text. Next use the *Show Scrap* command; then click a numeric button at the top of the scrap window shown above to identify the destination of the copy of the selected text. Close the scrap file using either the small square close box at the top left corner of the scrap window or the *Show Scrap* option again.

When you wish to retrieve the stored scrap, place the insertion point with the cursor and select *Show Scrap* from the menu. Select an active scrap by clicking on the desired active scrap number shown in **outline** style, and the scrap appears in the scrap window. If this is the correct scrap, use the *Paste* command to transfer the text. Close the scrap file using either the square close box at the top left corner of the scrap window or the *Hide Scrap* option (which toggles to *Show Scrap*).

3.14 Show Clipboard

The *Show Clipboard* command displays the most recent text copied to the Clipboard from this or a previous application. You may have placed text there with *Copy to the Clipboard* or from a desk accessory. Close the Clipboard using the *Close* command from the **File** menu or click the small square close box in the upper left corner of the window.

Trig

4.0 Trig

Trig is a typing aid. To use **Trig**, with the insertion point already placed, drag the mouse to the desired trigonometric or hyperbolic function name and release the mouse button.

Trig		
sin	cos	tan
csc	sec	cot
sin ⁻¹	cos ⁻¹	tan ⁻¹
arcsin	arccos	arctan
sinh	cosh	tanh
sinh ⁻¹	cosh ⁻¹	tanh ⁻¹

Palettes

5.0 Palettes

Point-and-click text entry allows you to avoid memorizing numerous complex keystroke combinations. As with the **Trig** menu discussed above, you can type all individual characters on the **Palettes** menu by simply pointing and clicking. Because some people may consider the symbols somewhat esoteric, we place the symbols in labeled groups and display the name of the symbol you select in the last row of the palette menu.



Palettes	Disc.	Fonts	FontSize	Style
Geometry	\angle	\perp	\parallel	\circ
Operators	$+$	$-$	\times	\div
Math/Calculus	f	π	Σ	Δ
Sets	\cup	\cap	\subset	\supset
Logic	\wedge	\vee	\neg	\forall
Arrows	\leftarrow	\rightarrow	\Uparrow	\Downarrow
Misc.	\mathfrak{A}	\mathfrak{B}	\mathfrak{X}	\mathfrak{Y}
Alphabet	BodoniItalic (BodoniItalic)			
Numerals	Times (Times)			
set (vector) multiplication				

You can select any symbol from the LaserWriter™ Symbol™ font using the mouse and possibly a modifier key from the keyboard. This feature dramatically increases the ease and speed with which you can use MathWriter especially if you are a novice or occasional user. With a single mouse click you can form the larger symbols that are a composite of several symbols discussed below.

The menu allows you to identify symbols by name and to select any using the mouse, but this procedure can be awkward and inconvenient for frequently used characters. For more efficient and faster access, place on-screen in full view each row of grouped characters in the pull-down palette relevant to your immediate needs but preserve as much of the precious on-screen equation window as possible. Simply select a menu row by dragging the mouse to the row title and release the mouse button; that row then appears along the bottom of the working window, and a check appears with that name on the pull-down palette. Typical of the Macintosh user interface, click on the same row title to remove the check from the menu and to remove the copy of the character group from the screen.

The on-screen *Alphabet* and *Numerals* groups permit mouse entry of a font in addition to the Greek alphabet.

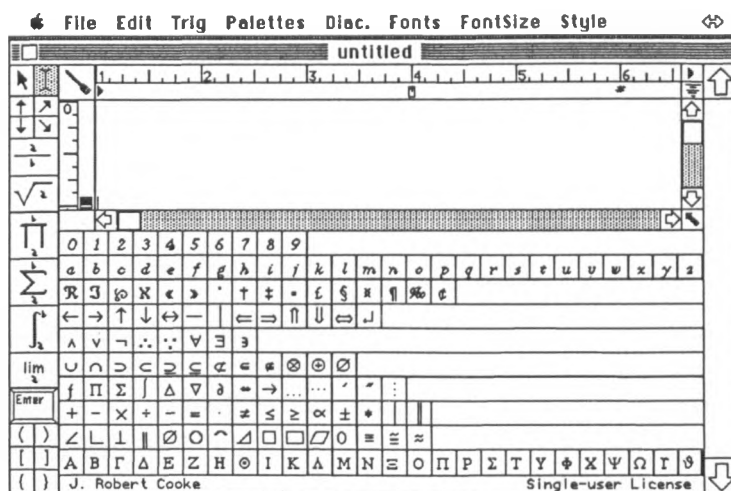
Italic type is often used for mathematical equations

The *Numerals* also provide quick and convenient access to the library of scraps (section 3.13). The *Alphabet* panel also allows the program to display on screen the user-supplied fonts of special, non-alphabetic symbols (such as Millinocket in the Maine fonts by Fulton and Harris), thereby circumventing your need to memorize non-mnemonic key strokes for them. You can also use this feature advantageously for entry of italic alphabets which are commonly used in equations.

Mathematical typesetting typically involves a mixture of Roman and italic characters. This on-screen alphabet solves two problems related to this mixture: (1) avoiding the exaggerated Macintosh generated italic style which alters the visual effect of the screen by using a font such as *BordonilItalic* or *IthacaItalic*, and (2) avoiding excessive use of the **Font**, **FontSize**, and **Style** menus. See the Appendix for further discussion of fonts.

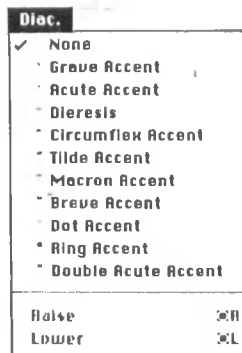
You can lock the on-screen font (sections 8.0 and 9.0) by clicking within the **Palettes** panel that identifies the font by name. The symbol used to designate a locked disk is the visual reminder. When locked, these alphabetic and numerical characters are **not** affected by subsequent changes in the **Fonts** menu until unlocked again. To unlock just click in the name again.

The following figure is a complete set of symbols for reference purposes. Selective assignment of symbols to the on-screen palettes avoids loss of active screen area and unnecessary screen scrolling.



The Alphabet and the Numeral groups in this palette are special. You can assign any font included in your system file to the Alphabet and Numeral categories. Use the **Fonts** menu discussed in section 7.0 to select the font. The underlined names correspond to the Laser printer fonts. Use these whenever possible if you use the LaserWriter. When you select Alphabet, the program adds the font name to the palette; and the characters of that font appear on the screen allowing you to click-type the entire equation. If you select Numeral, the program places the corresponding numerical characters of the same font on screen. Pressing the *Shift* key for 1 - 2 seconds causes the shifted character set to be displayed.

Diac.



Fonts

As mentioned in the discussion of the *Show Scrap* (section 3.13), the numerals also serve a dual function. If you want to copy selected text to one of the scraps, select the text and press the %key. A message appears on the numeral banner indicating that the numerals refer to the scrap numbers. With the %key still pressed, click on any of the numerals (0-9) to copy the selected text to the desired scrap. Outlined numerals indicate which scraps already contain data. Simultaneously pressing the % and *Option* keys allows you to paste from the scraps.

6.0 Diac.

Place diacritical marks above letters of the alphabet with this command. In MathWriter when the insertion point immediately follows a letter, the entries on the **Diac.** menu become operational. Click the desired accent mark.

You can adjust the vertical placement of the diacritical mark relative to the character it modifies using *Raise* and *Lower* or the keystrokes %R and %L. Each use of the command moves the diacritical mark further.

You can construct even more complex modifiers using the *Overlay Symbol* option on the **Edit** menu.

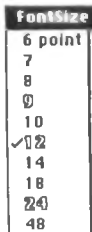
7.0 Fonts

This menu behaves in MathWriter just as it does in MacWrite and Word. Times™, the default, is indicated with a check. To change fonts highlight (select) the text you wish to change. Then click on the font you wish to use.

If you intend to use the LaserWriter, use the LaserWriter



FontSize



fonts; otherwise, excessive font substitution causes delays. Unlike Word or MacWrite, MathWriter identifies the LaserWriter fonts with underlining. The program retains font information even during a cut and paste operation. Your **Fonts** menu may not match this one but will reflect the current collection of fonts in your system file.

8.0 FontSize

FontSize presents a list of the permissible font sizes. The default is 12 point. The **Fonts** menu outlines the preferred font sizes of each font for screen presentation. The outlined sizes correspond to the screen font sizes presently in the system file. You can make additions to the preferred list using the Font/DA Mover utility. The LaserWriter smoothly prints Laser fonts for even the non-preferred, generated sizes that may appear ragged on the screen. The LaserWriter fonts are shown underlined on the **Fonts** menu; use these whenever possible if you use the LaserWriter as the output device.

MathWriter automatically selects the appropriate font size in most instances. For example, it automatically reduces the font size for subscripts, superscripts, limits for integrals, etc. It repeatedly reduces the font size for the first *two* levels of sub or superscripting. The smallest permissible font size is 6 and is supported by the LaserWriter. If you paste text with a small font size into an application that does not support very small fonts, the program substitutes the smallest permissible size. MacDraw, for instance, changes to 9 point everything below 9 point.

Existing type in an equation may be re-sized automatically. Use the mouse to select the equation or

Style

Style	
✓ Plain	⌘P
Bold	⌘B
<i>Italic</i>	⌘I
<u>Underline</u>	⌘U
Outline	⌘O
Shadow	⌘S
Lengthen	⌘=
Shorten	⌘-
Preferences...	
Align matrix rows	
Center matrix	
Descend matrix	

parts of equations and then select the desired font size. If the equation contains multiple font sizes, the *base* or *root* character takes the assigned size and all other characters are re-sized to maintain the original size relationships.

9.0 Style

The **Style** menu sets the font style and adjusts the spacing of the various constructs such as bracket size, subscript and superscript placement, spacing of the numerator and denominator in a fraction, and alignment of the elements in a matrix.

The first six entries in this menu correspond exactly to the first six entries in the corresponding MacWrite menu. The ⌘key equivalent use the first letter of the style name. The default text style is Plain but you can freely intersperse **Bold**, *Italic*, Underline, Outline, and Shadow characters. The style currently in use appears preceded by a check mark on the menu.

When you make changes to selected text, the program automatically uses the style and size of the first character for the replacement. Note that the **Font**, **FontSize**, and **Style** values reflect either the previous setting or, if you click into the text after an alphabetical character, the attributes of that character.

9.1 Plain (⌘P)

Plain is the default font style. Select *Plain* to undo **bold**, *Italic*, underline, outline, shadow, or any combination of these.

9.2 **Bold** (⌘B)

Bold changes the style selection to boldface type. You can use **Bold** simultaneously with other styles. Select Plain or reselect **Bold** to undo this type style.

9.3 *Italic* (⌘I)

Italic changes the style selection to italicized type. You can use *Italic* simultaneously with other styles. Select Plain or reselect *Italic* to undo this type style.

9.4 Underline (⌘U)

Underline changes the style selection to underlined type in the same font. Select Plain or reselect Underline to undo this type style.

9.5 Outline (⌘O)

Outline changes the style selection to outlined type in the same font. Select Plain or reselect Outline to undo this type style.

9.6 Shadow (⌘S)

Shadow changes the style selection to shadow type in the same font. Select Plain or reselect Shadow to undo this type style.

9.7 **Lengthen** (⌘+)

Lengthen increases the spacing **between characters**. First select (highlight) the text. Then use the Lengthen command as many times as needed to achieve the desired





stretching. Press the *Option* key in conjunction with *Lengthen* to increase only the spaces **between words** as is done with justify in a word processor. You can repetitively use this command as needed.

9.8 Shorten (⌘ -)

Shorten decreases the spacing **between characters**. First highlight the text. Then use the Shorten command as many times as needed to achieve the desired compression. Press the *Option* key in conjunction with Shorten to decrease only the spaces **between words**. You can repetitively use this command as needed.

9.9 Preferences...

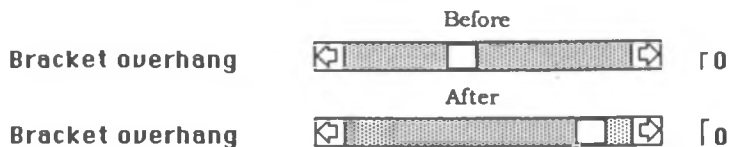
Preferences... sets spacing defaults for various mathematical structures. Unlike the adjustment for diacritical marks, this command sets defaults for all subsequent typing not just selected text. *Preferences...* functions the same as **Fonts**, **FontSize**, and **Style** above by modifying selected text to conform to changed preferences. The default positions and the corresponding scroll box positions are shown below.

Preferences	
Bracket overhang	 0
Superscript height	 0 ⁰
Subscript depth	 0 ₀
Gap:	<div> <input type="radio"/> Pi/Sigma </div> <div> <input type="radio"/> Fraction </div> <div> <input type="radio"/> Matrix </div> <div> <input checked="" type="radio"/> Other </div> <div>  0 </div>

9.9.1 Bracket overhang

The large parentheses, brackets, and braces are constructed of multiple pieces and extend vertically beyond the symbol they enclose. *Bracket overhang* sets the distance they extend.

Drag the scroll box or click on the scroll arrows to adjust the bracket overhang. The schematic to the right of the scroll bar shows the effect.



9.9.2 Superscript height

Superscript height adjusts the vertical placement of a superscript above the character with which it is associated.

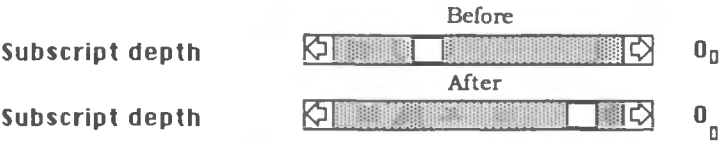
Drag the scroll box or click on the scroll arrows to change the superscript height. The schematic at the right of the scroll bar shows the effect.



9.9.3 Subscript depth

Subscript depth adjusts the vertical placement of a subscript below the character with which it is associated.

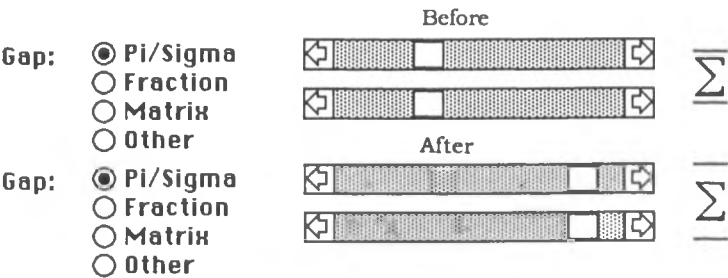
Drag the scroll box or click on the scroll arrows to change the subscript depth. The schematic at the right of the scroll bar shows the effect.



9.9.4 Gap: Pi/Sigma

Gap: Pi/Sigma sets the spacing of the lower and upper limit with respect to the Greek Pi and Sigma used to denote products and summation.

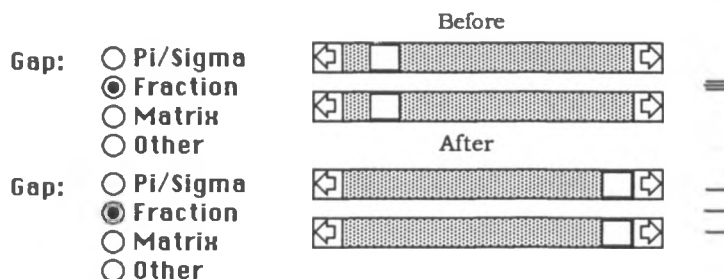
Drag the appropriate scroll box or click on the scroll arrows to independently change the upper or lower spacing. The schematic at the right of the scroll bar shows the effect.



9.9.5 Gap: Fraction

Gap: Fraction sets the vertical spacing of the numerator and denominator with respect to the fraction bar.

Drag the appropriate scroll box or click on the scroll arrows to independently change the upper or lower spacing. The schematic at the right of the scroll bar shows the effect.



9.9.6 Gap: Matrix

Gap: Matrix sets the row and column spacing for elements of a matrix.

Drag the appropriate scroll box or click on the scroll arrows to independently change the spacing of the columns and rows. The schematic at the right of the scroll bar shows the effect. Select *Center*, *Left*, or *Right* alignment of the elements of a matrix within its column. The actual spacing is twice that shown.

9.9.7 Gap: Other

Gap: Other sets the vertical spacing above and below any of the other symbols not covered under the above Gap settings.

Drag the appropriate scroll box or click on the scroll arrows to independently change the upper or lower spacing. (Recall that you click on a vertical up or vertical down arrow to *center justify* subsequent symbols above or below the symbol just typed.



$$\text{before } \begin{bmatrix} a & b \\ \frac{1}{2} & c \end{bmatrix} \begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix} \quad \text{after } \begin{bmatrix} a & b \\ \frac{1}{2} & c \end{bmatrix} \begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$$

9.11 Center matrix

Center matrix centers entire selected matrices as a unit in the vertical direction as shown below.

$$\text{before } \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix} + \begin{bmatrix} a & d & g \\ b & e & h \\ c & f & i \end{bmatrix} \quad \text{after } \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix} + \begin{bmatrix} a & d & g \\ b & e & h \\ c & f & i \end{bmatrix}$$

9.12 Descend matrix

Descend matrix aligns entire selected matrices as a unit as shown below.

$$\text{before } \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix} + \begin{bmatrix} a & d & g \\ b & e & h \\ c & f & i \end{bmatrix} \quad \text{after } \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix} + \begin{bmatrix} a & d & g \\ b & e & h \\ c & f & i \end{bmatrix}$$

ON-SCREEN PALETTE

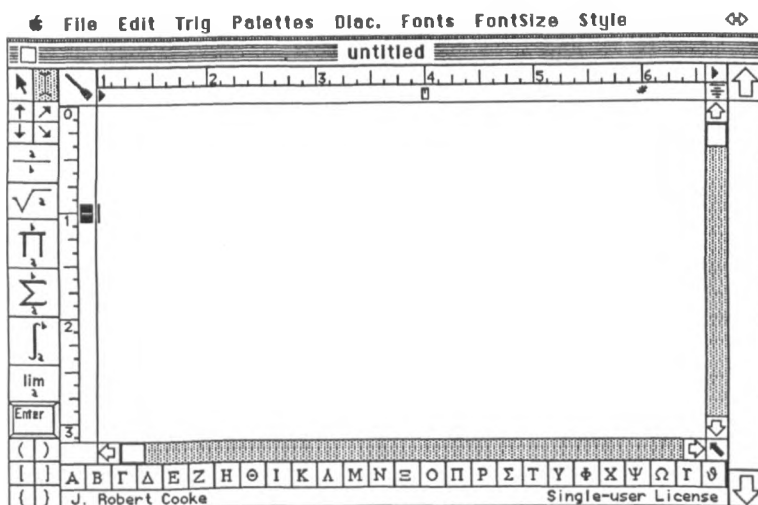
The tools and characters of the on-screen palette are discussed in the order (counterclockwise) they appear around the screen.

MathWriter Conventions:

The small "a" indicates the first entry expression and the small "b" indicates the second.

Use the *Enter* key to return to the previous depth.

Use the *Return* key to move from the current depth to the original depth (0) at once or to create a new line if the cursor is already at depth 0, which corresponds to the standard word processor line. (A positive depth indicates a superscript relation of a symbol to its parent or root symbol. Similarly, a negative depth is a subscript relation.)





10.0 Insertion Pointers

Use the **I-beam pointer** to establish the cursor at an insertion point or to begin text selection. This pointer corresponds to the familiar word processor pointer. Use the **arrow pointer** for accurate placement of the “dot” cursor within a mathematical structure when you need to edit within a structure. When you drag the point cursor (mouse button pressed), the substructure identified at the current cursor location is shown selected (i.e.,inversed). The point cursor appears at the right side of the currently selected structure when you release the mouse button.



11.0 Local motion / Subscripts & Superscripts

$$y = a x^2 + b x + c$$

$$\int_L F(s) ds$$

$$\overset{\text{Out}}{F} \quad \overset{\text{Out}}{F}$$

$$V^{\text{out}} \quad V_{\text{in}}$$

$$V^{\text{out}} \quad V_{\text{in}}$$

Use these commands simultaneously to move the cursor vertically and to reduce the font size. Use *Enter* (not *Return*) to restore the original depth and size.

The vertical up and down arrows center the subsequent input immediately above or below the previous character at a distance set by the *Gap: Other* command.

The inclined arrows move the cursor to the superscript and subscript position, automatically reduce the font size, and left justify the subsequent input.

Use the *Gap: Subscript* depth and *Superscript* height options in *Preferences* of the **Style** menu to set vertical placement



$$y = \frac{1+x}{1-x}$$

$$\frac{d}{dx}(u/v) = \frac{v \, du/dx - u \, dv/dx}{v^2}$$

12.0 Fraction

Use this command to produce fractions. The small “a” and “b” remind you to enter the numerator before the denominator.

1) When you *click the fraction icon*, the dot cursor moves to the numerator position and the fraction bar automatically and interactively increases to correspond to the length of the numerator. You can construct an arbitrarily complex numerator using the other commands on the palette and nest fraction bars within other fraction bars.

2) *Press Enter* (not *Return*) when you have completed the numerator, and the cursor moves to the denominator position. As you enter the arbitrarily complex denominator, the program automatically and interactively centers it. If the denominator exceeds the length of the numerator, the fraction bar automatically and interactively increases in length; and the program continually centers the numerator.

3) When you have completely entered the denominator, *terminate the formulation of the fraction structure using Return* (or *Enter*). The cursor then advances for the next input.

If a parenthesis, bracket, or brace precedes the fraction, the program automatically and retroactively adjusts in size the parenthesis, bracket, or brace and uses the same size closing parenthesis, bracket, or brace if they are typed on the same line. See the section on *Manual override* (27.0) and the *Overlay Symbols* feature (3.12) of the **Edit** menu if you need to defeat this automatic feature.



$$\sqrt{\sqrt{\sqrt{256}}} = 2$$



13.0 Square root

The square root symbol automatically and interactively adjusts in size as you enter an expression that can be of arbitrary complexity even containing other roots nested within it. Press *Enter* to complete and exit the root entry.

You can construct cube root and other such expressions using the *Overlay Symbols* option of the **Edit** menu.


14.0 Product

Click this icon to produce a product symbol. The size automatically and interactively adjusts as necessary. The program automatically reduces the font size for you to enter the *lower index* of the product first.

Press *Enter* (not *Return*) to move from the lower to the upper index and retain the diminished font size of the lower index. Press *Enter* to finish the product symbol.

$$\frac{1}{\Gamma(z)} = z e^{\gamma z} \prod_{n=1}^{\infty} \left[\left(1 + \frac{z}{n} \right) e^{-z/n} \right], |z| < \infty$$



Use Option  to create an *inline* equation.
(See section 16.0.)

$$1/\Gamma(z) = z \exp(\gamma z) \sum_{n=1}^{\infty} [(1 + z/n) \exp(-z/n)], |z| < \infty$$



15.0 Summation

Click this symbol to produce a summation symbol. The size automatically and interactively adjusts as necessary. The “a” and “b” symbols indicate that you enter the lower limit first and then the upper limit. The program automatically reduces the font size.


Press *Enter* (not *Return*) to move from the lower to the upper limit; the font size remains reduced.

Press *Enter* to complete the upper limit, reset the font size, and return to the level of entry for the terms of the summation.

$$\sum_{n=1}^3 (1/n^2) = \frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2}$$

$$J_\nu(z) = \left(\frac{z}{2}\right)^\nu \sum_{\kappa=0}^{\infty} \frac{(-z^2/4)^\kappa}{\kappa! \Gamma(\nu + \kappa + 1)}$$



Use *Option*  to obtain a compressed *inline* summation with the limits of integration placed within the vertical limits of the integral symbol. (See section 16.0.) $\sum_{n=1}^{\infty} (1/n^2)$



16.0 Integral

Click this symbol to produce an integration symbol. The size automatically and interactively adjusts. The “a” and “b” symbols indicate that you enter the lower limit first

$$\int_{x=0}^2 x \, dx = \frac{x^2}{2} \Big|_0^2 = \frac{2^2}{2} - \frac{0^2}{2} = 2$$

and then the upper limit. The program automatically reduces the font size when you enter the lower limit.

Press *Enter* to move from the lower to the upper limit; the font size remains reduced.

Press *Enter* to complete the upper limit, reset the font size, and return to the level of entry for the integrand.

For an adjustable integral the integral icon must be clicked from the **Palettes** menu. To obtain an indefinite integral sign, press *Return* just after clicking the integral icon to circumvent the entry of the limit of integration.



You can create an equation using a compressed integral expression in which the limits of integration are centered above and below the integral symbol. Simply click the integral symbol *while* the *Option* key is pressed.

The small, non-adjustable integral sign from the Symbol font can be used for an in-line equation. You can paste the in-line equation $\int_{\xi=1}^4 \phi(\xi) d\xi$ into the text of WriteNow.

Note: 10 point type is small and difficult to use with inline equations.

$$\int u \, dv = u \, v - \int v \, du$$

$$\int (a + b x)^n dx = \frac{(a + b x)^{n+1}}{a(n+1)}, n \neq -1$$

Merging Equations with Text

Note: Unlike MacWrite 4.5 and Word 1.05, the new WriteNow™ word processor allows you to merge with a line of text a MacPaint or MacDraw PICT document or Clipboard transferred scrap. The most immediate use of this capability is the after-the-fact addition of equation numbers. With the earlier word processors you had to enter the equation number as part of the display equation which you pasted into the word processor document. A special tab symbol # for equation alignment has been provided in MathWriter. See section 24.0 and the Appendix for further discussion.

$$\frac{d}{dc} \int_{a(c)}^{b(c)} f(x, c) dx = \int_{a(c)}^{b(c)} \frac{\partial}{\partial c} f(x, c) dx + f(b, c) \frac{db}{dc} - f(a, c) \frac{da}{dc}$$



17.0 Limit

Click this icon to display the limit symbol. The program automatically reduces the font size and positions the cursor for you to enter the limit expression "a".

$$\gamma = \lim_{m \rightarrow \infty} \left[1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \cdots + \frac{1}{m} - \ln m \right]$$



18.0 Enter

This is an on-screen mouse-click equivalent to the *Enter* key.

()
[]
{	}

19.0 Parentheses, brackets, and braces

We show these grouping symbols in standard size. The program automatically and interactively adjusts the sizes as needed. It even adjusts them retroactively when subsequent input requires larger symbols. If the closing parenthesis occurs on the same line as the opening one, it matches the opening one in size.

$$\left\{ \left[(1+x) \sin \phi \right] \frac{\exp(-x^2)}{2\pi} \right\}$$

You can individually resize the grouping symbols as described later in the section on *Manual override*. These symbols are also available from the keyboard.

















To create a **matrix** enter both the opening and closing symbols as adjacent characters. Beginning with column one enter by columns the elements of the matrix.

- When you complete each element, press *Enter* (**not Return**) to move to the next element in that column.
- After you enter the last element in a column, hold down the *Option* key as you press *Enter* to move the cursor to the top element of the next column to the right.
- After you type all elements of the matrix, *then and only then*, press *Return* to exit from the matrix. If you exit prematurely, you can use the **arrow insertion pointer** to resume entry.

Enter				
()	3			
[]	2,1	←		
{ }	A	B	Γ	Δ
	J.	Robert		

The program provides an indication of the input level in the rectangular area to the left of the left scroll arrow. The numbers appearing there show the row and the level in that row. This information is especially useful when you enter complex structures such as matrices.

Here are some row and depth (not column) indicator examples.

 x ¹ .	 1	 x ₂ ¹ .	 -1
 [1]	 1,0	 $\begin{bmatrix} 1 & 4 \\ 2 & \\ 3 & \end{bmatrix}$	 1,0
 $\begin{bmatrix} 1 \\ 2 \end{bmatrix}$	 2,0	 $\begin{bmatrix} 1 & 4 \\ 2 & 5 \\ 3 & \end{bmatrix}$	 2,0
 $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$.	 3,0	 $\begin{bmatrix} 1 & 4 \\ 2 & 5 \\ 3 & . \end{bmatrix}$	 2,1

20.0 Greek alphabet

The on-screen point and click Greek alphabet stretches across the bottom of the screen. The lower case letters are normally visible; press the *Shift* key for upper case letters. The program gives two alternate forms of chi and theta following omega. This alphabet shifts immediately between upper and lower case.

The *user-selected* on-screen alphabet display, however, changes only after the *Shift* key has been depressed more than about a second. The correct case is entered even if the screen updating has not yet appeared. (Note: The immediate screen updating was suppressed for speed considerations.)

A	B	Γ	Δ	E	Z	H	Θ	I	K	Λ	M	N	Ξ	Ο	Π	P	Σ	T	Υ	Φ	X	Ψ	Ω	ι	θ
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

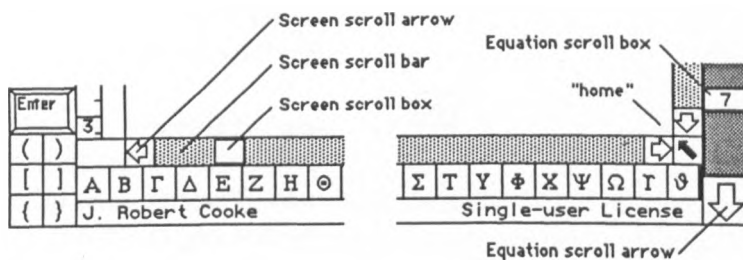
21.0 Licensee identification

The program identifies the licensee on the bottom line of the screen. We do not encumber this copyrighted program by copy protection. Instead we include this gentle reminder of the identity of the licensee of this licensed program. Your license prohibits the removal of this identification or the copyright notice. Your license and the copyright laws prohibit unlawful copying of this program.

22.0 Scroll bars

Horizontal and vertical scroll bars are adjacent to the screen. You can rapidly make large horizontal or vertical movements of the screen viewing area by dragging the *screen scroll* boxes. Clicking in the screen scroll arrows produces movement in small steps. Clicking the solid diagonal arrow at the bottom right of the screen quickly scrolls the equation screen to its top left or "home" position.

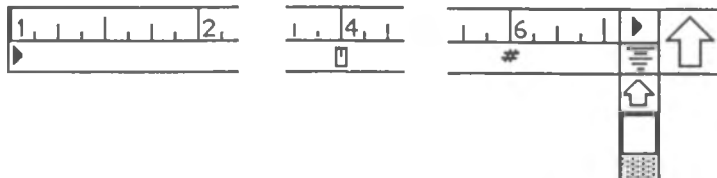
The larger arrow at the bottom right of the screen, part of the right hand border of the viewing screen, is the *equation page scroll* arrow. The rectangular equation scroll box displays the number of the current "equation page".



To scroll through the equations, drag the equation scroll box or click the mouse in the large equation scroll arrows at the top or bottom ends. Click in the shaded scroll bar above (or below) the equation page scroll box to move upward (downward) ten equation pages or to the extreme equation page.

23.0 Rulers

An inch ruler is located along the left and top sides of the screen. At the extreme top right is the equation scroll arrow. Note that the Word ruler starts at 0, rather than 1.



24.0 Horizontal tabs

To the immediate left of the large equation page scroll arrow at the extreme top-right of the screen is a supply of **Horizontal Tabs**.



One such tab, initially at the far left, is always on the ruler. You can take other tabs from the supply and place them along the ruler. These tabs are especially useful in aligning equations with respect to equal signs.



Use the # tab to align **equation numbers**. This tab is always present on the ruler and is always the right-most tab.



Use the remaining tab (shown at 4 on the ruler) as a **guide for centering** equations. Move this tab to the desired center.



Then click in the centering box above the small vertical screen scroll arrow. This program command produces an alignment pattern of vertical lines drawn vertically from the centering tab and of increasing line width at additional one inch offsets from this line.


Move the triangular tabs to interactively shift the equation parts. Remember that you can align and resize the equations even after they are pasted into another application such as MacWrite.

You can move all tabs as long as they do not follow the equation number tab, overlap an existing tab, or precede the first tab (initially located under the 1 on the horizontal ruler).

25.0 Vertical Tabs

The rectangular boxes along the left margin of the screen just to the right of the vertical ruler are vertical tabs. Drag the boxes to reposition the line(s) of an equation.

Note: The vertical tab example was produced as a MacPaint document.



$$\int \frac{dx}{[(a+bx)(c+dx)]^{1/2}} = \frac{2}{(-bd)^{1/2}} \arctan \left[\frac{-d(a+bx)^{1/2}}{b(c+dx)^{1/2}} \right], \quad bd < 0$$

$$= \frac{-1}{(-bd)^{1/2}} \arcsin \left(\frac{2bdx + ad + bc}{bc - ad} \right), \quad b > 0, d < 0$$

$$= \frac{2}{(bd)^{1/2}} \ln \left| [bd(a+bx)]^{1/2} + b(c+dx)^{1/2} \right|, \quad bd > 0$$

Option<drag> allows partial overlapping of the equation lines. Use *Option Shift* <drag> to switch the top-to-bottom order of searching for overlapping.



26.0 Refresh icon

Use the broom refresh icon anytime the screen becomes cluttered with fragments left from repeated updating of the screen. Simply click here to redraw the equation on a clean background.

27.0 Manual Override of Automatic Symbol Sizing

If you need to over-ride the automatic symbol sizing of the program for integral, absolute value, matrix norm, parentheses, brackets, braces, and the divisor slash, you can manually adjust them.

$$\int \left| \left\{ \{ \} \right\} \left[\right] \left(\right) \right| /$$

- To stretch one of these symbols, place the selection or insertion point immediately to the right of the symbol. Then simultaneously press and hold down the three keys $\&$, *Shift*, and *Option*. The program highlights or inverses the symbol and a small square box or “handle” appears immediately above and below the highlighted symbol. Drag these handles to stretch the symbol. To return the symbol to its smallest size, click once in the highlighted symbol; to re-expand the symbol, click twice in the highlighted symbol and release the mouse button.
- To resize the font size of the text, select by dragging and choose the new font size. When you select text which begins at the base line of the equation, all of the selected text is rescaled; the original relative sizing of characters is preserved.

Note that the automatic formatting ignores stretched symbols. If you stretch a symbol outside the guides for a particular line and then delete that symbol, that portion of the symbol outside the guides will remain until the screen is refreshed using the broom icon.

Appendices

4.0 MathWriter and Switcher

Effective use of MathWriter requires the frequent transfer of typeset equations to another application such as MacWrite. You can accomplish the transfer by storing on the disk individual equations in MacPaint and MacDraw files or by using the standard Clipboard as the exchange format. To use the Clipboard before the existence of Switcher, you would have had to transfer an equation to the Clipboard, quit MathWriter, activate the other application, and then transfer the equation from the Clipboard into the application.

Switcher allows you to make a more spontaneous, interactive transfer. If your computer has sufficient memory for both of your applications (for example MathWriter and MacWrite) to be resident at the same time, you can quickly transfer equations between them. Only one of the applications is active at once; the other is inactive until you use Switcher to toggle between them. We describe only the procedures for the use of Switcher 5.0.1 with MathWriter. You can obtain the *Switcher Construction Kit* from your Apple dealer for more general instructions.

When you want to transfer an equation to MacWrite, use **⌘K** or *Copy to Clipboard* on the pull-down **Edit** menu to copy the contents of the screen to the Clipboard. Click on one end of the double arrow symbol at the right extremity of the menu bar to switch to MacWrite. After you select with the cursor the insertion point in your document, use **⌘V** or *Paste* from the **Edit** menu to complete the transfer.

The *Write/Math* Switcher document supplied with the 400K distribution diskette assumes that you have a copy

of MacWrite 4.5 on the disk in the external drive. You can also save the MacWrite document onto the disk in the external drive disk. With 800K drives, both MathWriter and the other application can reside on the internal drive.

Begin a work session as follows:

- Turn on the power switch of the Macintosh.
- Insert your working copy of MathWriter in the internal drive.
- Insert the MacWrite disk in the external drive.
- Double click the icon of the MathWriter disk.
- Double click the *Write/Math Switcher* document.

The program automatically loads both applications.

Use Switcher to transfer equations as follows:

- If necessary, click on one end of the double arrow at the top right of the screen to bring MathWriter to the foreground.
- Create an equation as described in Chapter Two of the MathWriter User's Guide.
- Transfer the equation to the Clipboard using the *Copy to Clipboard* option in the **Edit** menu. [If the *Auto Copy* option located just below the *Copy to Clipboard* option on the **Edit** menu has been checked, the program automatically performs this step.]
- Hold *Option* down while you click on the Switcher arrow at the top right of the screen. [Do not click on the shaft of the double-headed arrow as this needlessly brings the Switcher screen to the fore. If you accidentally click on the shaft, click again on one of the arrows. If you select *Always convert Clipboard in*

the *Options* item of the Switcher menu, Switcher automatically converts the Clipboard.]

- Use the mouse to place the insertion point and then select **Paste** from the **Edit** menu (or just use the %V keyboard equivalent).
- Click on the Switcher arrow when you wish to return to MathWriter.

Repeat this process as often as needed.

Always exit from a Switcher session following the steps below. *Never just turn the power off.*

- **Save** your document for this application.
- **Quit** the currently active application.
- Switch to the other application.
- **Save** your document for this application.
- **Quit** the currently active application.
- Click the close box on Switcher.

You can create additional Switcher documents to automatically activate other applications with MathWriter.

- Double-click on the Switcher icon.
- Click to select one of the four application slots.
- Select an application from the dialog box and click the Open button.
- Repeat this process for the other application.
- Click on a Switcher arrow to make one of the applications active.

MathWriter requires at least 280K of memory to function reliably. This minimum size information is included in MathWriter. MathWriter makes extensive use of memory; if necessary, disk storage can substitute for extra memory. Set a preferred memory size of 512K for MathWriter when you configure Switcher for your application.

4.1 MathWriter Sample Output

This section displays an excerpt from our finite element analysis program using four different font combinations. Times and Symbol are the standards supplied with MathWriter. BodoniItalic illustrates the use of italics commonly associated with mathematical typesetting. Machias is a bit-mapped screen font developed by William Fulton and Joe Harris (Brown University). The Princeton Laser Font was developed by Philip and Harvey Lam (Princeton University).

Illustration Using Times and Symbol Fonts

Stresses in the element are obtained from the strains and the material properties.

$$\{\sigma\} = [D] \{\epsilon\} \quad (3.28)$$

4×1 4×4 4×1 (rows × columns)

where $[D]$ is the material property matrix.

The material property matrix for axisymmetric geometries is:

$$[D] = \frac{E(1-\mu)}{(1+\mu)(1-2\mu)} \begin{bmatrix} 1 & \frac{\mu}{1-\mu} & \frac{\mu}{1-\mu} & 0 \\ \frac{\mu}{1-\mu} & 1 & \frac{\mu}{1-\mu} & 0 \\ \frac{\mu}{1-\mu} & \frac{\mu}{1-\mu} & 1 & 0 \\ 0 & 0 & 0 & \frac{(1-2\mu)}{2(1-\mu)} \end{bmatrix} \quad (3.29)$$

The finite element matrix equation defining axisymmetric elasticity in a 3-node triangular element is:

$$\left[\begin{array}{c} 2\pi \bar{r} A [\bar{B}]^T [D] [\bar{B}] \end{array} \right] \{U\} = \{F\} \quad (3.30)$$

6×6 6×1 6×1 (rows × columns)

where \bar{r} is the r -coordinate of the centroid of the element and \bar{B} is the shape function derivative matrix evaluated at the element centroid.

The form of equation 3.30 matches the form of equation 3.14. Note that this element equation has the same dimensions as does equation 3.23 for the two-dimensional Cartesian coordinate systems even though the dimensions of $[D]$, $[B]$, $\{\epsilon\}$, and $\{\sigma\}$ differ in these two coordinate systems.

Illustration Using Times, Symbol, and BodoniItalic Fonts

Stresses in the element are obtained from the strains and the material properties.

$$\{\sigma\} = [D] \{\epsilon\} \quad (3.28)$$

4×1 4×4 4×1 (rows × columns)

where $[D]$ is the material property matrix.

The material property matrix for axisymmetric geometries is:

$$[D] = \frac{E(1-\mu)}{(1+\mu)(1-2\mu)} \begin{bmatrix} 1 & \frac{\mu}{1-\mu} & \frac{\mu}{1-\mu} & 0 \\ \frac{\mu}{1-\mu} & 1 & \frac{\mu}{1-\mu} & 0 \\ \frac{\mu}{1-\mu} & \frac{\mu}{1-\mu} & 1 & 0 \\ 0 & 0 & 0 & \frac{(1-2\mu)}{2(1-\mu)} \end{bmatrix} \quad (3.29)$$

The finite element matrix equation defining axisymmetric elasticity in a 3-node triangular element is:

$$\left[2\pi \bar{r} A [\bar{B}]^T [D] [\bar{B}] \right] \{U\} = \{F\} \quad (3.30)$$

6×6 6×1 6×1 (rows × columns)

where \bar{r} is the r-coordinate of the centroid of the element and \bar{B} is the shape function derivative matrix evaluated at the element centroid.

The form of equation 3.30 matches the form of equation 3.14. Note that this element equation has the same dimensions as does equation 3.23 for the two-dimensional Cartesian coordinate systems even though the dimensions of $[D]$, $[B]$, $\{\epsilon\}$, and $\{\sigma\}$ differ in these two coordinate systems.

Illustration Using Machias and Symbol Fonts

Stresses in the element are obtained from the strains and the material properties.

$$\{\sigma\} = [D] \{\epsilon\}$$

4x1 4x4 4x1 (rows x columns)

(3.28)

where $[D]$ is the material property matrix.

The material property matrix for axisymmetric geometries is:

$$[D] = \frac{E(1-\mu)}{(1+\mu)(1-2\mu)} \begin{bmatrix} 1 & \frac{\mu}{1-\mu} & \frac{\mu}{1-\mu} & 0 \\ \frac{\mu}{1-\mu} & 1 & \frac{\mu}{1-\mu} & 0 \\ \frac{\mu}{1-\mu} & \frac{\mu}{1-\mu} & 1 & 0 \\ 0 & 0 & 0 & \frac{(1-2\mu)}{2(1-\mu)} \end{bmatrix} \quad (3.29)$$

The finite element matrix equation defining axisymmetric elasticity in a 3-node triangular element is:

$$\left[\begin{matrix} 2\pi \bar{r} A [\bar{B}]^T [D] [\bar{B}] \end{matrix} \right] \{U\} = \{F\}$$

6x6 6x1 6x1 (rows x columns)

(3.30)

where \bar{r} is the r-coordinate of the centroid of the element and \bar{B} is the shape function derivative matrix evaluated at the element centroid.

The form of equation 3.30 matches the form of equation 3.14. Note that this element equation has the same dimensions as does equation 3.23 for the two-dimensional Cartesian coordinate systems even though the dimensions of $[D]$, $[\bar{B}]$, $\{\epsilon\}$, and $\{\sigma\}$ differ in these two coordinate systems.

Illustration Using Princeton and Symbol Fonts

Stresses in the element are obtained from the strains and the material properties.

$$\{\sigma\} = [D] \{\epsilon\} \quad (3.28)$$

4x4 4x4 4x1 (rows x columns)

where $[D]$ is the material property matrix.

The material property matrix for axisymmetric geometries is:

$$[D] = \frac{E(1-\mu)}{(1+\mu)(1-2\mu)} \begin{bmatrix} 1 & \frac{\mu}{1-\mu} & \frac{\mu}{1-\mu} & 0 \\ \frac{\mu}{1-\mu} & 1 & \frac{\mu}{1-\mu} & 0 \\ \frac{\mu}{1-\mu} & \frac{\mu}{1-\mu} & 1 & 0 \\ 0 & 0 & 0 & \frac{(1-2\mu)}{2(1-\mu)} \end{bmatrix} \quad (3.29)$$

The finite element matrix equation defining axisymmetric elasticity in a 3-node triangular element is:

$$[2\pi \bar{r} A [B]^T [D] [B]] \{U\} = \{F\} \quad (3.30)$$

6x6 6x1 6x1

where \bar{r} is the r-coordinate of the centroid of the element and \bar{B} is the shape function derivative matrix evaluated at the element centroid.

The form of equation 3.30 matches the form of equation 3.14. Note that this element equation has the same dimensions as does equation 3.23 for the two-dimensional Cartesian coordinate systems even though the dimensions of $[D]$, $[B]$, $\{\epsilon\}$, and $\{\sigma\}$ differ in these two coordinate systems.

4.2 Report of Suggestions and Problems

We have crafted this first version of MathWriter with great care, but in any application of this size some blemishes are inevitable. We wish to continue the refinement and extension of MathWriter as a high quality, low cost tool. Your suggestions and constructive criticisms can speed this process. However, please send only non-proprietary suggestions which you are willing to have us use freely.

Name _____ Date _____

Address _____

City _____ State _____ Zip _____

Version (from About MathWrite) _____

Hardware configuration: RAM _____ K, ROM version _____

Drives _____ Hard disk _____

System version _____ Finder version _____

Printer _____ Printer resource version number _____

Name of Licensee (from screen) _____

Describe the new feature(s) desired.

Or

If possible, describe the problem so that we can reproduce it.

Mail to: Cooke Publications
P.O. Box 4448
Ithaca, NY 14852

4.3 Other Cooke Publications Titles

A. Applied Finite Element Analysis Series

1. MacElastic
2. MacPoisson
3. PC-Elastic
4. PC-Poisson

These are large, visually oriented programs for solving two-dimensional and axisymmetric problems of elasticity and processes governed by Poisson's equation, for example, steady state heat conduction, electrostatics, ideal fluid flow, diffusion, and seepage. The student versions are limited to 300 degrees of freedom. The student version of the program and text book are priced for individual student ownership. The professional version allows the professional to use maximum available memory.

The programs feature automatic mesh generation, automatic bandwidth reduction, extensive graphical output, and extraordinary attention to user friendliness. These programs require at least 512K of RAM and dual disk drives.

B. Forthcoming educational titles

Cooke Publications plans to develop a utility program to convert MathWriter data files into standard T_EX source files.

Also we plan to release the IthacaItalic™ Laser and screen fonts.

We are currently working on a course management program suitable for use with both small and very large courses. Both IBM PC and Macintosh versions are being developed. University-wide as well as individual licenses are anticipated.

[Make a **copy** of this page to use as an order form.]

COOKE PUBLICATIONS LICENSE AGREEMENT AND SOFTWARE ORDER FORM

Cooke Publications, P.O. Box 4448, Ithaca, New York 14852

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For the **IBM/PC***

For the Apple **MacIntosh***

n.a.		<input type="checkbox"/> MathWriter & text	\$49.95
<input type="checkbox"/> PC-Elastic Student	\$39.95	<input type="checkbox"/> MacElastic Student	\$39.95
<input type="checkbox"/> PC-Elastic text**	\$19.95	<input type="checkbox"/> MacElastic text**	\$19.95
<input type="checkbox"/> PC-Elastic Professional	\$495.00	<input type="checkbox"/> MacElastic Professional	\$495.00
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<input type="checkbox"/> PC-Poisson text**	\$19.95	<input type="checkbox"/> MacPoisson text**	\$19.95
<input type="checkbox"/> PC-Poisson Professional	\$495.00	<input type="checkbox"/> MacPoisson Professional	\$495.00

* All programs require at least 512 K RAM. The finite element programs should be used with two disk drives. The IBM PC also requires the math coprocessor.

** The finite element text book is included with the professional versions but is priced separately to accommodate usage with university-licensed software in a laboratory.

☐ Check Enclosed (N.Y. Residents include sales tax)

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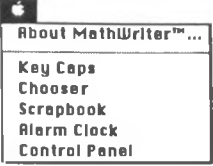
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5. INDEX

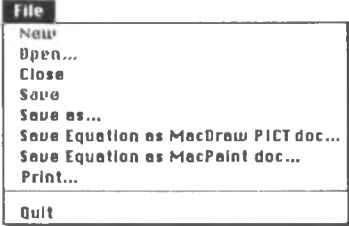
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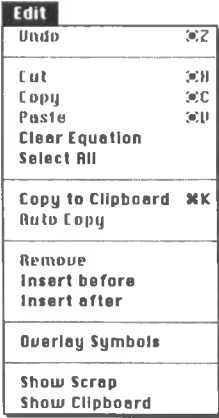
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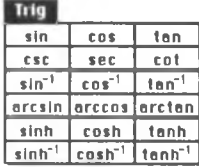
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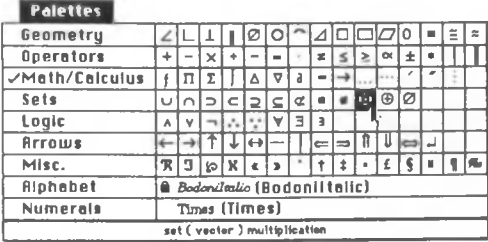
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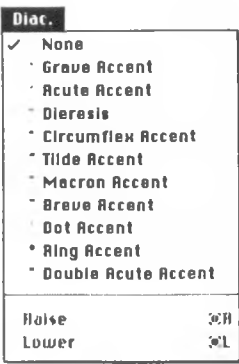
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58



62



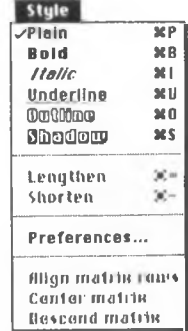
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63



64



Keyboard Commands

%+	Lengthen selection (add pixel between characters) [See %Option+] (§9.7)
%-	Shorten selection (delete pixel between characters) [See %Option-] (§9.8)
%B	Set font style to bold (§9.2)
%C	Cut (remove) the selection and place it in the current scrap. (§3.3)
%I	Set font style to italic (§9.3)
%K	Copy current equation page into the current scrap (§3.7)
%L	Lower the diacritical mark on the character to the left of the cursor (§6.0)
%O	Set font style to outline (§9.5)
%Option +	Lengthen selection (add pixels only between words) [See %+] (§9.7)
%Option -	Shorten selection (delete pixels only between words) [See %-] (§9.8)
%P	Change font style to plain and undo any other modifiers such as bold, italic, underline, outline, and shadow (§9.1)
%R	Raise the diacritical mark on the character to the left of the cursor (§6.0)
%S	Set font style to shadow (§9.6)
%ShiftOption	Produce handles for manual stretching of the integral, absolute value, parenthesis, bracket, brace, or forward slash to the immediate left of the insertion point (§27.0)
%U	Set font style to underline (§9.4)
%V	Paste the current scrap contents at the insertion point (§3.4)
%Z	Undo last command (§3.1)
Enter	Terminate input at the current depth (See <i>Return</i>)
Return	Return to the base depth for input if not at the base level; start a new line if cursor is already at the base level (See <i>Enter</i>)
%click an on-screen numeral -	Paste a selection into scrap library (§3.13, 5.0)
%Option click an outlined on-screen numeral -	Paste a library scrap at the insertion point (§3.13, 5.0)
Option click equation scroll arrow -	Insert an equation page (<i>Insert After</i> or <i>Insert before</i>) (§3.10,3.11)
Option click on Switcher arrow -	Required to Convert Clipboard for new applications format (§4.2) (Not required if <i>Auto copy</i> is active.) (§3.8)
Option Tab	Insert a tab at the current insertion point (§24.0) Note: Used to format computer code.

